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# What Young People Should Know

## The Reproductive Function in Man and the Lower Animals

By
Prof. Burt G. Wilder

*With Twenty-six Illustrations*

Boston
Dana Estes & Company
Publishers

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"To the pure all things are pure."

"Well stated information never yet contributed to human inflammation."—

"The knowledge of the human body belongs to every man, woman and child, and has no more necessary connection with physic than with art, industry, or any of the other occupations that we do in the body and by the body."—WILKINSON.

"Whether or not we ought to hide this subject from the young, if we could, the truth is that we cannot if we would."—

"The propensity which we find most difficult to control, and which, when uncontrolled, is the source of the greatest physical and moral evil, is that whose regulation is left most completely to chance."—WARE.

"There is a healthy knowledge and an unhealthy unclean ignorance."—FOTHERGILL.

There should be no room for the imagination in regard to the structure or the functions of the reproductive organs.

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# PREFACE.

The complete title of this little work should be "Some of the Things Young People should Know." For the writer believes that the whole subject should be explained as soon as it can be understood by the young. This opinion is more fully expressed in Appendix A.

This volume, however, is intended to include only those things which most directly concern young unmarried persons of both sexes.

Writing chiefly for students and for unprofessional readers, the author, in reproducing some of the views upon comparative embryology recently published by Alexander Agassiz, Haeckel, Van Beneden, Waldeyer and others, has endeavored to present conflicting opinions with impartiality.



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The rapid progress of microscopic anatomy renders it impossible that any work should fully represent the state of knowledge at the date of its publication, but it is hoped that what is here given may serve as a guide to more advanced studies.

In Appendix B is introduced an important lecture by Professor Claude Bernard, which was received too late for incorporation with the text.

The text and illustrations are largely derived from standard works. References are made upon a plan explained upon page 189.

Since writers upon sexual physiology are liable to be placed in an undesirable literary category, a nearly complete list of papers hitherto published by the author is given in Appendix C.

It is proper to state that this is, in no sense, a medical work, and that the author does not now practice medicine or surgery in any form.

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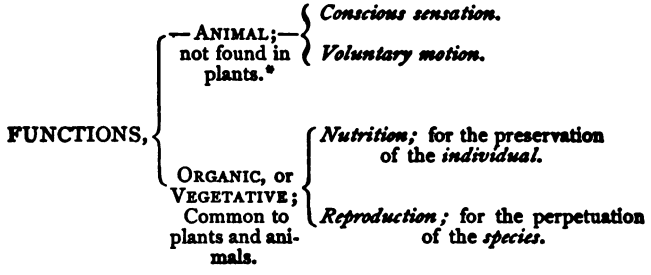
# WHAT
# YOUNG PEOPLE SHOULD KNOW.

## GENERAL REMARKS UPON THE REPRODUCTIVE FUNCTION.

Excluding *mental operations*, and the functions of *motion* and *sensation*, all the acts and processes of plants and animals form two groups, those of *nutrition*, and those of *reproduction*. This grouping of functions is indicated in the following table:




*None deny that in contrasting the *entire kingdoms* of animal and vegetable life, the former manifests sensation and motion in a higher degree than the latter; but when our highest botanical authority publishes



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The *nutritive functions* have for their object the preservation of the life of the *individual*, and are, relatively, *selfish* in their nature; digestion, circulation, absorption, etc., have no direct reference to other individuals.

But the *reproductive functions* are intended to perpetuate the *species;* and new individuals are thus the result of their exercise, even with the lowest forms; while in most of the higher forms *two separate individuals* must coöperate in order to effect the object; and with many animals, the offspring and parents, for a time at least, constitute a community, which seems to prefigure the family relation among men. The reproductive functions are therefore relatively *unselfish** and social in their nature.

The simplest form of reproduction is met with among the simplest organisms. The moners (a group of *Protozoa*) have no structure, properly speaking; the whole animal is a mass of protoplasm, living jelly, without even a nucleus; yet they not only live and move, and nourish themselves by the appropriation

"How Plants *behave*," one is apt to doubt the correctness of the old distinctions; and it is certain that some vegetable organisms manifest quite as much activity as other low forms which are supposed to be animal. Probably the real ground of distinction is not yet ascertained.

*That is, with animals, and, normally, with men; but, as will be seen, they are often the medium of manifestation of the most intense selfishness

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of other matter, which is, as it were, *engulfed* rather than taken and swallowed, but also multiply themselves. The *Protamœba* (fig. 1) merely subdivides at a certain point, and so two individuals are produced where there was one. The same is the case with the *Bathybius*, a diffused protoplasmic mass, covering the bottom of the ocean in some places. Some other mo-

FIG. 1.

FIG. 1.—Multiplication among the lowest organisms, the *Monera*, from Haeckel. *A*, an entire moner *(Protamœba)*; *B*, the same with signs of subdivision into two parts; *Ca* and *Cb*, two individuals formed by subdivision of the first.

ners, however, as the *Protomyxa aurantiaca*, described by Haeckel, (78, *165*,) pass through several changes of form in the course of their reproduction and seem to prefigure the process as it occurs among the higher animals.*

With the *Amœba*, the process is nearly the same as in the *Protamœba*, but complicated by the existence

*A brief account of the Monera is contained in the Popular Science Monthly for December, 1873, p. 81.

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of a *nucleus* and *nucleolus*, which subdivide like the main mass, so that each resulting part presents likewise a nucleus and a nucleolus. (*Haeckel*, 78, *169*).

With others of the Protozoa, in place of a nearly equal division of the individual into two, neither of which can properly be called parent or progeny, we find that the individual produces a large number of *sporules* or "zoöspores" smaller than itself, which develop into separate individuals. This act may be accomplished by a single individual, but is often preceded by union of two individuals (conjugation), although here no distinction of sex has been discovered. For a synopsis of this kind of reproduction with the Noctilucæ, see Packard, (106, Jan., 1875, *47*.)

But with the large majority of animal forms the reproductive powers are delegated to certain more or less circumscribed portions of the individual. These organs are also more or less completely included within the organism, instead of being borne upon its surface. They are thus the producers of *internal* buds, instead of external. They also manifest a peculiar structure and arrangement. And finally, although in some cases borne upon a single individual, the reproductive parts appear of two kinds, with distinct locations and properties. And now neither one alone is capable of perpetuating the species; but the two kinds of products must *unite* before a new individual can arise.

One of these products is a nucleated cell which,

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under certain conditions, is capable of transforming and developing into a new being; this is the *egg*, or *ovum*, and the organ which produces it is the *ovary*. The other product is usually in the form of minute particles, the *zoösperms*, which are formed within cells secreted by the *testis;* when set free they present no *structure*, but usually one end tapers as a "tail" by means of which they execute rapid vibratory movements. With plants the corresponding product is the *pollen*. The contact of the pollen or zoösperms with the ovum is the first and essential condition of its development; and now the terms *male* and *female*, *masculine* and *feminine*, are employed to designate the organs which produce the zoösperms and ova respectively.

Animals and plants with which both kinds of organs exist upon one individual are called *monœcious*, or *hermaphrodite*. Each individual is at the same time male and female; and in many of them the arrangements are such as to allow the ova to be impregnated by the zoösperms of the same individual; as with the tape-worm. In a few, however, as the earth-worm (*Lumbricus*) and the snail (*Helix*), the impregnation is *reciprocal;* two individuals come together and the ova of each are fertilized by the zoösperms of the other. But in most of the higher plants and all the vertebrate animals* the essential organs are borne

* "In several fishes of the genus *Serranus*, a testis has been observed



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upon distinct individuals, which are then of opposite sexes, male and female, and the species is said to be *diœcious*. And now these sexual individuals are apt to present peculiarities of structure and habit; sometimes so marked as to lead to their description as distinct species. And with these sexual peculiarities of animals are to be compared the mental and physical differences which exist between men and women, leading to a division of labor which allows the highest perfection of body and mind, (79).

The sexual reproduction above described is known also as *gamogenesis*. In all the Vertebrates (Fishes, Batrachians, Reptiles, Birds and Mammals) this is the only known manner of reproduction. With them, therefore, and with all others in which new individuals arise only by the coöperation of the two sexes, and thus always in the same manner, the reproduction is technically termed *homogenesis*.

But there are some creatures which, at intervals, fail to produce the two sexes. The multiplication of individuals during those intervals is therefore *non-sexual* or *asexual*. This is technically called *agamogenesis* And the whole process of reproduction with such animals is termed *heterogenesis*, since gamogenesis alternates with agamogenesis.

overlying the ovary, and a similar hermaphroditism has been observed occasionally in Cyprinoids and in some other fishes." (*Rolleston*, 37, *lxxix*).

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A familiar example of this is offered by the Aphides, or plant-lice. Starting with a brood of perfect males and females, which unite and produce fertilized eggs, we find that from these eggs are hatched neither males nor females in the perfect condition, but rather what are called *imperfect females* only. These develop within themselves little bodies (pseud-ova), which rapidly assume an organization like the parent, and are *born alive*. In these a second brood of imperfect females are in like manner viviparously produced, and the process is repeated for several (eight or nine) generations. Then there appear perfect males and females as at the first, and the former cycle is repeated. (*Burnett*, 10, *Owen*, 80, *Spencer*, 11).

With other animals, as the Hydroid polyps, a true sexual generation (which will be described farther on) alternates with a *budding from the surface*, or *external metagenesis*. With still others, as the *Distoma*, (an internal parasitic worm), there occurs a kind of *internal budding*. "From the egg of the *Distoma* there is produced a rudely-formed creature known to naturalists as the 'King's yellow worm.' As this increases in size, the greater part of its inner substance is transformed into young animals called *Cercariæ;* . . . until at length it becomes little more than a living sack full of living offspring." (*Spencer*, 11, *213*). This is called *internal metagenesis*.

Attempts have been made to arrange a tabular view

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of the several kinds of reproduction, (*Spencer*, II, *215*). But that author admits that "we cannot, by any logical dichotomies, accurately express relations which, in Nature, graduate into each other insensibly."

Notwithstanding many exceptions, it appears that, upon the whole, as we ascend in the scale of organization, the processes become more and more complex. But even in the highest stage there is really only a modification of the simple division which occurs in the lowest; for ovum and zoösperm are merely *internal offshoots*, minute though they often are, from a parent stock. And it might be shown how gradual is the transition between the reproductive processes of the two extremes of animal life, the Moner and the man. For the differences relate to the *proportion between the stock and the bud*, and to the complexity of the organs and processes required for elaborating the zoösperms and the ovum, for effecting their contact, and for protecting and nourishing the latter during its development into a new individual.

## HUMAN REPRODUCTION.

### ANATOMY OF THE ORGANS.

Of the reproductive organs, as of most others, the clearest idea may be gained by first studying the *manner of their formation.*

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At about the fifth week of embryonic life, there has been developed, on each side of the vertebral column, an oblong reddish mass, called, from its discoverer, the *Wolffian body*. The Wolffian bodies are at this time the largest organs in the abdomen, and in a fœtal pig, a little over half an inch long, Dalton found them to constitute one thirty-second of the entire weight. Each Wolffian body consists of transverse tubules, which open at their outer end into a tube, the *Wolffian duct*. By their structure there seems no doubt that these bodies secrete a urine-like fluid from the blood, and pour it through their ducts into the base of the allantois, part of which afterward becomes the bladder. They are thus the *primordial kidneys*, and it is probable that in the fishes and in the Batrachians (frogs, salamanders, etc.), no others are developed. (*Huxley*, 63, *106*).

But in all other Vertebrates they are only temporary. In man they are hardly to be found after the second month, while the true kidneys and the internal reproductive organs are developed near them, and soon surpass them in size.*

*The following figure (Fig. 2) well indicates the commonly accepted view of the relation between the Wolffian bodies and the internal reproductive organs. But, as will be explained farther on, there is reason to think that the latter are double in each sex, upon each side; that is, that instead of a single body becoming either ovary or testis, both ovary and testis coexist, only one, however, persisting in most cases.

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FIG. 2.

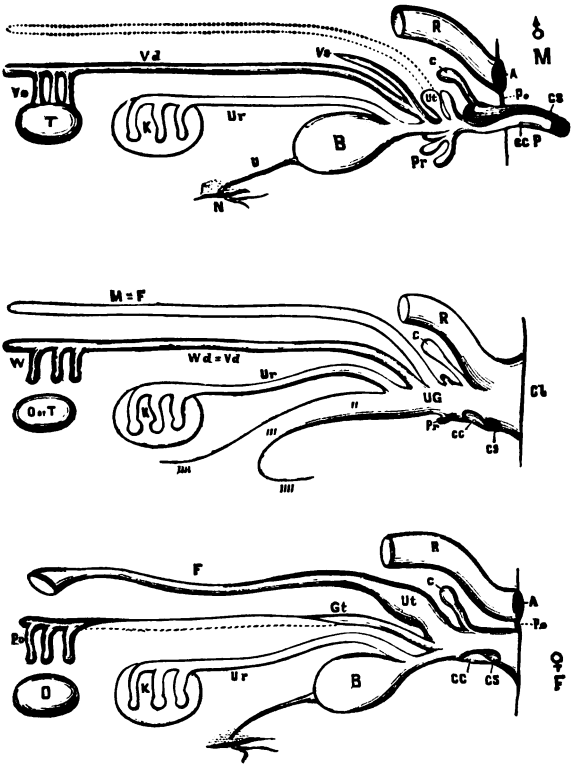


FIG. 2.—Diagrams of the development of the reproductive organs; from Huxley; slightly altered: in all, the organs are horizontal with the upper (anterior) ends to the left. The middle figure represents the organs before the sex is apparent; the upper one, (M ♂) the male; the lower, (F ♀) the female. The following lettering is common to the three figures: *R*, rectum; *K*, kidney; *Ur*, ureter; *C*, Cowper's gland; *CC*, corpus cavernosum; *CS*, corpus spongiosum. The following are confined to one or two of the figures: *Cl*, cloaca; *A*, anus; *Pe*, perineum; *P*, penis; *UG*, uro-genital sinus, which be-

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comes the vagina in the female, and the membraneous and prostatic part of the urethra in the male; '', that part of the allantois which dilates into the bladder; ''', that part which contracts into the urachus; '''', that part which is expanded into the true allantois at an early stage, but which afterwards forms the umbilical cord, and is cut off at the navel, or umbilicus, *N; Pr*, prostate gland; *O* or *T*, the organ which becomes ovary in the female *O*, and testes in the male, *T; W*, Wolffian body, which becomes the vasa efferentia, *Ve*, in the male, and the parovarium, *Po*, in the female; *Wd*, Wolffian duct, which becomes the vas deferens, *Vd*, in the male, but in the female dwindles into the duct of Gärtner, *Gt; Vs*, the vesicula seminalis; *M = F*, the duct of Müller, which becomes the Fallopian tube, or oviduct, in the female, the hinder part, in connection with that of the opposite side, forming the uterus, *Ut;* in the male, only this hinder part of each remains as a rudimentary uterus, or *utriculus*. It must be remembered that the kidneys, Wolffian bodies, and the ovary and testes are in *pairs*, although only one is shown, while the rectum and bladder are single, median organs.

The *true kidneys* (*K*) are at first little rounded masses upon the dorsal* surface of the Wolffian bodies, and wholly concealed by them in a front view; but

*Naturally, but in some respects unfortunately, the relative position of organs in man has been described according to his natural attitude; but this is not the natural attitude of any other vertebrate, nor is it the attitude in which the human body itself is examined or compared. It seems better, therefore, to adopt at once the terms which would apply to the *normal horizontal position* of vertebrates, and so by *anterior* and *posterior* to indicate toward the head or toward the opposite end of the body respectively; by *dorsal* and *ventral* to indicate toward the back or belly; while *right* and *left*, *inner* and *outer*, *deep* and *superficial*, are used in the ordinary sense; the adverbs *dorsad* and *ventrad*, *mesiad* and *distad* are readily understood from their form and the context. For a discussion of natural attitude and normal position, see Agassiz, 71.

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their rapid growth in a forward direction soon causes the Wolffian bodies to appear as little rounded bodies near their hinder end. Each kidney has a duct, the *ureter* (*Ur*), which opens into the base of the bladder a little in front of the Wolffian duct.

About the same time that the kidneys are formed dorsad of the Wolffian bodies, two oval-shaped organs make their appearance on their ventral side; these are the internal generative organs, or genital glands —the *ovaries* in the female, and the *testes* in the male. They are at first undistinguishable from each other, either in size, shape or position; but as the kidneys increase in size, the ovary becomes elongated and flattened, and assumes first an oblique and then a transverse direction; while in the male the testis becomes rounder and thick, and retains its vertical position.

From the above account it would seem impossible that both the ovaries and the testes could be formed in the same individual. Yet there are recorded several such cases among human beings, constituting *complete bisexual* hermaphrodism, anatomically, at least; although it is probable that *functionally* the individual was either male or female. A rat in which this variety seems to exist has lately been put into my hands for examination. More often, however, the ovary is developed upon one side and the testis upon the other, constituting *lateral* hermaphrodism. Most of the so-called cases of hermaphrodism are only ap-

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parent or spurious, resulting from an abnormal arrest or excess of development of the accessory parts in one or the other sex. (44, 52, and 90, *427*).

The last essential factor in the development of the reproductive organs is a tube called the "duct of Müller" (*M*), which is formed on each side, near the Wolffian duct, and, like it, opens into the allantois behind the outlet of the Wolffian duct, and so between it and the alimentary canal. Finally, two glandular structures are formed about the hinder part of the allantois, the *prostate* (*Pr*) and *Cowper's gland* (*C*). And upon the ventral surface of the wall are seen thickenings, which afterwards become the *penis* (*P*) or the *clitoris*.

We have now the condition of things represented in fig. 2. *R* is the *rectum*, the termination of the alimentary canal; this leads into a short and broad cavity, the *cloaca* (*Cl*), into the anterior part of which opens the allantois, or urogenital sinus (*UG*). At this stage, therefore, the fœtus of man and other mammals resembles the birds and reptiles, by presenting a single outer aperture, into which open the rectum behind and the urogenital sinus in front. Anteriorly this sack widens out into a broad membrane which envelopes the fœtus in a way elsewhere shown. At present we are concerned with the fact that into its dorsal side open three pairs of tubes or ducts, as follows: most anteriorly the two *ureters* (*Ur*);

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next, the *Wolffian ducts* (*Wd*); and lastly the *Müllerian ducts* (*M*).

This is the indifferent or (apparently) sexless condition of the urogenital organs. The following changes occur during the establishment of the female type: the larger part of the Wolffian ducts disappear; leaving the anterior portion and the diminished Wolffian body attached to the ovary of that side as a little body known as the *parovarium* (*Po* and fig. 9), and the hinder part as a short tube, the *duct of Gärtner* (*Gt*). The two Müllerian ducts unite near their connection with the urogenital sinus, and, for a greater or less distance, form a single cavity. This cavity later becomes partly subdivided by a constriction into a hinder tube-like portion, the *vagina* (*V*), and an anterior, and usually dilated portion, the *uterus*, or *womb* (*Ut*). In the human species this cavity is the only place in which the development of the child normally occurs; and the anterior and longer portions of the ducts become what are called *Fallopian tubes* (*F*). But in many animals, as cats and dogs and pigs, the hinder part and sometimes the whole of the tube is adapted to the reception and development of the young. The thickenings upon the ventral wall of the cloaca become a small prominence, the *clitoris*. The rectum and the urogenital sinus become separated by a horizontal partition, *perineum* (*Pe*). That part of the sinus which intervenes between the

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openings of the ureters and of the Müllerian ducts, (now the *uterus*) contracts into a narrow passage, the urethra. The next anterior portion, on the contrary, dilates into an ovoid *bladder* (*B*); while the third portion, again, contracts, and, in the adult, becomes an impervious cord, the *urachus* (*U*). Beyond the body wall, the allantois is continued as the umbilical cord, connecting the placenta with the fœtus, as hereafter described; and the point where the body-wall afterwards closes in upon it is called the *umbilicus*, or navel (*N*).

In the male, the changes last described are the same as with the female, but in other respects there are great differences. The Wolffian body becomes adjoined to the testis; the Wolffian duct thus becomes the duct of the testis and is now called the *vas deferens* (*Vd*). Near its hinder end, an elongated pouch is formed, which is called *vesicula seminalis* (*Vs*). The Müllerian ducts disappear, excepting only their hinder ends. These unite, as in the female, but the result is only a small sack, which afterwards is wholly enclosed and concealed within the enlarged prostate gland (*Pr*). The thickenings of the wall of the urogenital sinus become greatly enlarged and constitute the *corpus spongiosum* and the *corpora cavernosa* of the penis (*P*), which now projects from the body, enclosing the single canal, or prolonged urethra, which is now, as in the female, separated from the rectum by the perineum (*Pe*).

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We see, then, that with most of the organs the differences between the sexes depend upon the greater or less size of identical parts. The male nipple represents the female breast; the utriculus is a rudimentary uterus, and the penis an enlarged clitoris.*

* Until within a few years, it has been supposed that the ovary and testis are likewise identical organs, which assume different features of structure and function in the two sexes. But the remarkable observations of Van Beneden upon the Hydroids, (see page 78), are so far corroborative of the results of recent investigations upon other animals, and of the supposed cases of true hermaphrodism, (page 24), as to justify the belief that the primitive ovary and the primitive testis are two distinct organs, originating, the former from the entoderm and the latter from the ectoderm. This view is provisionally adopted by Haeckel, whose Table of the Homologies of the Sexual Organs, (104, *680*), is here partly reproduced. The former view is indicated in the similar table in Quain (1, *1001*).

| COMMON EMBRYONIC. | MALE. | FEMALE. |
|---|---|---|
| Male genital gland, (product of ectoderm ?), | Testis, | Primitive testis; (remains with some Batrachians). |
| Female genital gland, (product of entoderm ?), | Primitive ovary; (remains with some Batrachians), | Ovary. |
| Wolffian Body, | Epididymis, | Parovarium. |
| Wolffian duct, | Vas deferens, | Duct of Gaertner. |
| Müllerian duct (lower or hinder portion), | Utriculus, | Uterus and Vagina. |
| Müllerian duct (upper or anterior portion), | Cornu of utriculus (with some animals), | Oviduct. |
| Common blastema, | Cowper's glands, | Glands of Bartholin. |
| " " | Penis, | Clitoris. |
| Outer folds, | Scrotum, | Labia majora. |
| Inner folds, | Skin of lower surface of penis, | Labia minora (nymphæ). |

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We are now better prepared to consider the organs as they appear in the adult.

## THE MALE ORGANS.

The male reproductive organs are partly contained within the pelvis, and partly suspended between the thighs; this group, including the penis, and the scrotum containing the testes, are hence called *external* organs, while the others are called *internal.* The pelvis also contains two large organs not connected with the reproductive function, namely, the *rectum*, or terminal portion of the intestine (shown in the section of the female pelvis, fig. 8), and the *bladder*. This latter, when distended, will hold a pint; its walls are in two layers, the outer muscular and contractile, the inner mucous.* The muscular

*As a rule those cavities which, either directly or indirectly, communicate with the air, are lined by *mucous* membrane; such are the mouth, the stomach and intestine, and the nostrils: while those which are closed are lined by a smoother membrane, called *serous;* such are the abdomen, the chest, and the cranium; and the serous membranes of those cavities are distinguished by the names *peritoneum*, *pleura*, and *dura mater* respectively. For general contrast, we may say the serous membrane is *satiny*, while the mucous is *velvety*. It will be seen hereafter that the abdomen of the female mammal forms an exception to the rule, and such exceptions are common among the fishes, where the abdomen may open outwardly through the "abdominal pores." Among the Selachians

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FIG. 3.

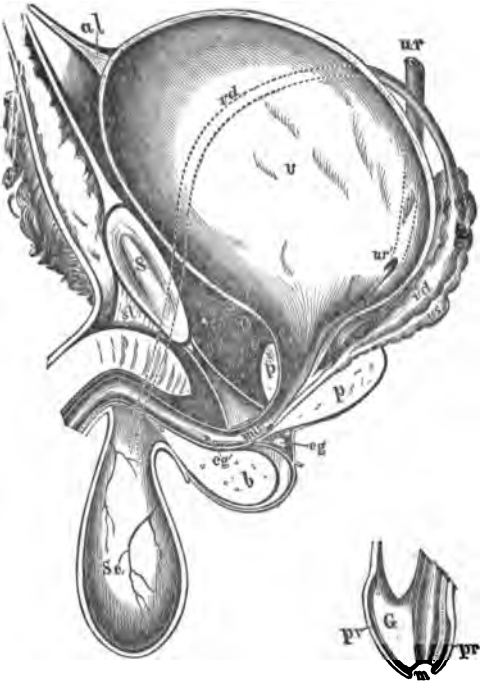


FIG. 3.—The male reproductive organs, as if cut vertically upon the median line; (from Gray, with a few alterations). The glans penis (*G*) the prepuce (*pr*) and the meatus (*m*) are shown in the detached portion. *v*, the urinary bladder, as if distended; *ur*, right ureter; *ur'*, valvular orifice of the ureter into the bladder; *S*, symphysis pubis; *sl*, suspensory ligament; *m*,

(sharks and skates) indeed, there is another opening from the abdomen into the pericardium; and as the fluid in both these cavities is decidedly salt, we may imagine that the sea-water is admitted through the opening.

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meatus urinarius; *Sc*, scrotum; *b*, bulbous portion of the corpus spongiosum; *mu*, membraneous portion of the urethra; just behind the letters *mu* is a notch, indicating the point where the ejaculatory duct enters the urethra; *p*, *p*, the prostate gland; *cg*, right Cowper's gland; *cg'*, its orifice, in the urethra, the course of its duct being indicated by the dotted line; *vd*, right vas deferens, or spermatic duct, the two dotted lines indicating its course from the scrotum upwards upon the side of the bladder; *vs*, right vesicula seminalis; *al*, urachus, the contracted remnant of the allantois.

coat may be again subdivided into two sets of fibers, the one running lengthwise of the organ, and the other, or circular fibers, around it. The muscular coats enable the bladder to expel all or nearly all of its contents; their action is involuntary, but can be assisted by the muscular walls of the abdomen. Outside the muscular coat, the hinder wall of the bladder is also covered by the peritoneum.

The *kidneys* are not shown in the figure; they lie, one on each side of the back-bone, in the loins, and the urine is brought down from each by a tube, the *ureter* (*ur*); this enters the hinder wall of the bladder by a valvular orifice (*ur'*), which prevents any backward flow.

The long diameter of the bladder inclines ventrad and forward, and at the apex there is attached a fibrous band, the *urachus* (*al*). This runs from the bladder to the navel, or umbilicus, upon the front of the abdomen, and is the contracted and imperforate remnant of the allantois, a fœtal membrane which will be described in connection with development.

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During development, the urachus is pervious, so that the cavity of the bladder is continuous with that of the allantois externally; even at birth, the canal sometimes remains open, so that for a short time the urine may escape at the umbilicus, where the allantois (umbilical cord) has been cut, (*Gray*, 3, *666*). In a fœtal pig, which has been recently examined by me, a bladder-like dilatation of the allantois exists outside the body wall.

The outlet from the bladder is backward and ventrad through a constriction called the *neck*, which is surrounded by a fleshy mass, the prostate gland (*p*, *p*), At this point the circular muscular fibers are numerous, forming the *sphincter* of the bladder. The canal which continues outward from the bladder through the penis, is called the *urethra*. The first portion, surrounded by the prostate, is the prostatic portion; the next (*mu*) the membraneous portion, and the remaining and longest part is the spongy portion, from being surrounded by the *corpus spongiosum*.

The penis, or organ of copulation, is attached to the pelvic bones by a suspensory ligament (*sl*). It is nearly cylindrical when flaccid, but when erect and distended has a triangular, prismatic form, the broadest side, or dorsum, being turned upward, as seen in a transverse section (fig. 4). The body of the penis consists of two lateral masses,—the *corpora cavernosa* (*C*), and a single mass below and upon the middle

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line, which immediately surrounds the urethra, and is the *corpus spongiosum* (*S*). These three masses consist mainly of blood vessels, forming a net-work supported by fibrous bars (*trabeculæ*). These vessels are supplied by arteries, of which one is shown (*a*), on each side of a vein (*v*). This vascular net-work is called *erectile tissue*, from the fact that the rapid fill-

FIG. 4.

FIG. 4.—Transverse section of the penis. *S*, corpus spongiosum, surrounding the urethra; *C*, *C*, corpora cavernosa, separated by a vertical median partition; *v*, large vein; *a*, artery; *n*, nerve. (From Quain).

ing causes a distension and erection of the part. A like tissue occurs in the *clitoris*, and in the *nipples*.

The corpus cavernosum thickens behind into a bulb, upon which rests a small body, "Cowper's gland," (fig. 3, *cg*) whose duct opens into the urethra opposite the middle of the length of the bulbous portion. The *corpora cavernosa* have rounded posterior ends, and the suspensory ligament is attached to the fibrous capsule which covers them.



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The spongy bodies enlarge anteriorly into the *glans penis*, which is flattened from above downward and presents a double fold, the *prepuce*, of which the inner surface is mucous membrane, continuous with that covering the glans, while the outer layer is skin, continuous with that of the body of the penis. Ordinarily the glans is wholly covered by the prepuce, but during erection the glans protrudes more or less, and during coition it is wholly uncovered, the preputial fold is obliterated and all the coverings are rendered tense. The tension of the mucous membrane covering the glans is increased by the fact that below, just behind the meatus, the prepuce is attached by a median and unyielding fold, the *bridle*, or *frœnum*, by which, during erection, the glans is as if pulled downward.*

Below the root of the penis hangs a bag of integument, the *scrotum* (fig. 3, *Sc*); its cavity is double, and each compartment contains the testis (or testicle) of that side. The outer and hinder side of the testis is an elongated curved mass, the *epididymis*, the structure of which will be seen in figure 5. The testes measure from one and a half to two inches in length, and from one inch to one and a quarter in width; the weight varies from six to eight drams, the left being usually a little the larger.

* Circumcision consists in the removal of the prepuce, or foreskin; the effect is to lessen the sensibility of the glans, and to obviate the irritation which is apt to occur unless the parts are kept scrupulously clean.

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The internal structure of the testis is quite complex, on account of the minuteness of the parts and their great number, but the general arrangement is well shown in figure 5.

FIG. 5.

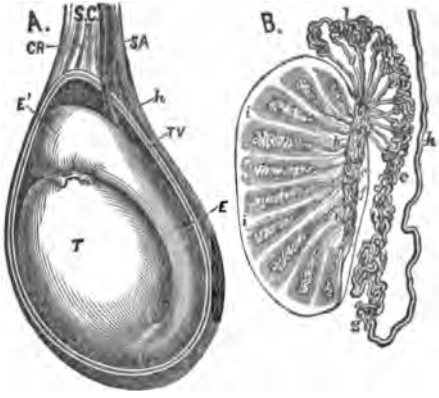


FIG. 5.—(From Quain). *A*, the left testis, seen from the left side, after its investing serous membrane, the *tunica vaginalis*, *TV*, has been laid open. *T*, the testis; *E*, the epididymis; *E'*, its head; *SC*, the spermatic cord; *CR*, the cremaster muscle; *SA*, spermatic artery; *h*, the vas deferens.

*B*, plan of a vertical section of the testis, showing the *arrangement* of the ducts, but not their *number* or their *length*, both of which points are variously stated. *i–i*, fibrous partitions which separate the testis into lobes; the lobes consist of finely coiled tubes which terminate in nearly straight tubes, the *vasa recta*, *b*. These, at the back part of the testis, form a dense mass of tubules, *rete vasculosa*, *f*. From the upper part of this radiate several tubes, the *vasa efferentia*, *d*. These again form a convoluted mass, the *epididymis*, *e*, which ends below in a single tube, the *vas deferens*, *h*.

As seen in the figure, the testis consists of a great number of minute coiled tubes, separated from each

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other by fibrous partitions. The straighter terminations of these are called *vasa recta* (*b*). These unite in a net-work, *rete vasculosa* (*f*). This, above, gives off several *vasa efferentia* (*d*), which again by foldings and intertwinings constitute the *epididymis* (*e*), which ends below in a single large tube, the *vas deferens* (*h*), and this, after rising upon the outer border of the epididymis, ascends, together with the vessels and nerves of the testis, all together constituting the *spermatic cord* (*SC*). This cord passes through a narrow canal which connects the cavity of the scrotum with that of the abdomen, and is called the *inguinal canal.* The *vas deferens* ascends still higher to the side of the bladder (fig. 3 *vd*). Here it turns and ascends again nearer the middle line than the ureter of the same side, and likewise becomes thicker and sacculated, as seen in figure 6. Just at the margin of the prostate, the *vas deferens* gives off an elongated and pouched diverticulum, the *vesicula seminalis* (*vs*), which serves as a reservoir for the semen. In order to understand the way in which the *vas deferens* opens into the urethra, it is necessary to describe the parts shown in figure 6.

Upon the middle line, and surrounded by the prostate in man, but in many animals projecting beyond it, is a sack-like organ, (fig. 6 *u*,) which opens by a slit-like orifice in the middle line of the urethra. This organ corresponds to the uterus and vagina of the fe-

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FIG. 6.

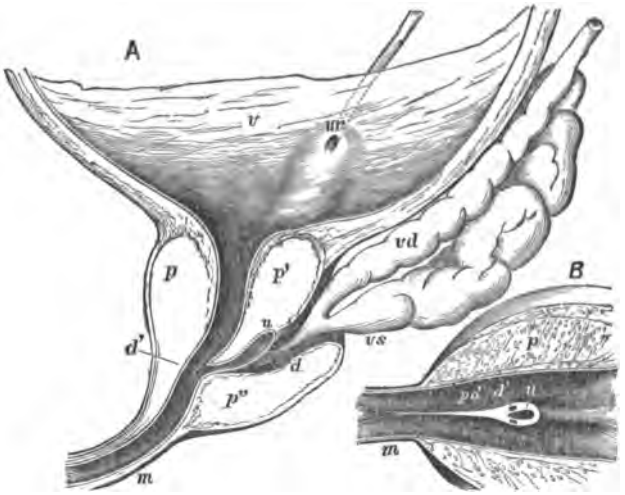


FIG. 6.—*A*, vertical section of the neck of the bladder and beginning of the urethra; (from Quain). The lettering is the same as in figure 3, with the addition of the designations of some parts not there shown; *u*, the utriculus; *d'*, orifice of the duct of the vas deferens.

*B*, horizontal section of the prostatic portion of the urethra, showing the median orifice, *u*, of the utriculus; and the two minute orifices, *d'*, of the spermatic ducts; *pd*, orifices of the prostatic ducts; *m*, membranous portion of the urethra. The left border of the prostate gland is not shown.

male. And is hence termed the *uterus masculinus;* also the *utriculus*, the *vesicula prostatica*, and the *Weberian organ*, after its discoverer. In a few animals where it is very large, and where the seminal vesicles are small or absent, it is supposed to serve as a receptacle of semen.*

*Article, "Vesicula Prostatica," Cycl. of Anat. and Phys., Vol. IV., p. 1415.

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Upon each side of the orifice of the utriculus, on a slight ridge which surrounds it, there is a smaller opening (fig. 6 *d'*), the outlet of the *vas deferens* (*vd*); this has been described in connection with the testis, of which it is the duct. The very indirect course of the *vas deferens* is due to the fact that the testis is originally in the abdomen, as already described upon page 24. Each testis is formed near the kidney of the same side; during gestation it gradually descends, and shortly before birth passes out through the gap in the muscles of the abdomen at the groin (the inguinal ring), and enters the scrotum.

In man and some other mammals, it remains here during life, and the canal of communication closes up so as to be wholly filled by the spermatic cord, consisting of the vas deferens, and the vessels and nerves of the testes, which have, of course, accompanied it in its descent. When the canal is not sufficiently closed, or when a violent exertion is made, the neighboring loops of intestine may be forced through the canal into the scrotum, constituting *inguinal hernia.* In some animals (rats, rabbits, etc.,) the canal is permanently open, and the testis remains in the abdomen, except at the breeding season, the *rut.*

The *vas deferens* is about two feet long. Its inner or lining membrane is mucous, and its walls contain some unstriped or involuntary muscular fibers, which give it a contractile power. The *vesicula* has a similar structure.

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The essential product of the testis has been already mentioned; it is the *zoösperm*, or *spermatozoön*, or *spermatic* or *seminal filament*, (fig. 7).

FIG. 7.

FIG. 7.—The zoösperm, magnified about 800 diameters. The left-hand figure shows the "head" from the flattened side; the other from the narrower border. (From Kölliker).

The zoösperms are formed in immense numbers in the minute lobes of the testes,* and conveyed outward through the vasa recta to the epididymis, and so into the vas deferens. Together with the zoösperms, there is formed a slight amount of fluid. This fluid

*The zoösperms originate within cells and, in some animals at least, undergo considerable changes of form before reaching what may be regarded as their adult condition. The student is advised to examine them for himself, as is easily done with the frogs and toads; the zoösperms are very large in the *Menobranchus*, or "dog-fish salamander," of the lakes.

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and the zoösperms constitute the real semen, as it exists in the vasa deferentia and vesiculæ seminales; but at the time of its ejaculation, there is added to it the secretion of the prostate gland, and also a less quantity of fluid from the glands of Cowper, which lie upon the hinder ends of the bulbs of the corpora spongiosa and open into the urethra.

According to Kraus the prostatic fluid is capable of prolonging the vitality of the zoösperms for a much greater period after ejaculation than would be the case in its absence.

## THE FEMALE ORGANS.

As in the male there are first, the *essential* organs, or *testes;* and second, the *accessory* organs, the tubes for conveying the semen: so, in the female, we find first, the *essential* organs, or *ovaries;* and second, those which are intended to receive and nourish the ovum during its development. In our description, however, it will be easier to begin with the general view of the organs as seen in a vertical section of the female pelvis (fig. 8), as compared with that of the male (fig. 3).

With these, even more than with the male organs, one is struck by the intimate association of the generative apparatus with the organs of excretion. They

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## FIG. 8.

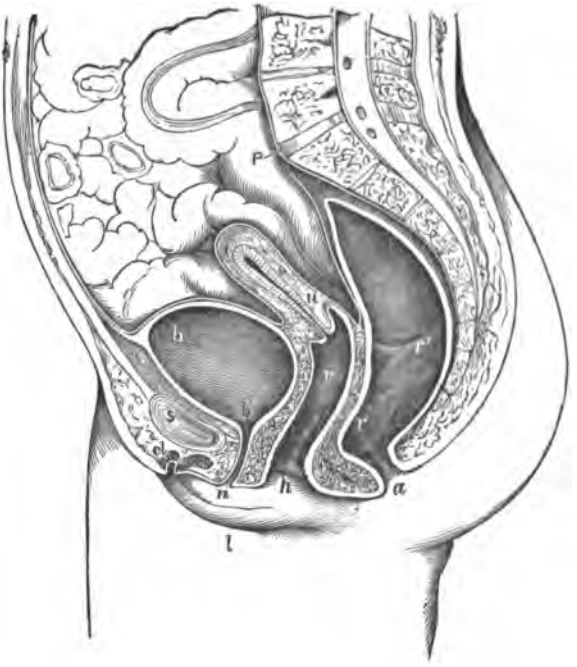


FIG. 8.—Vertical section of the female pelvis upon the median line; *P*, the promontory of the sacrum, below which are seen the bones of the sacrum and coccyx; in front are the coils of intestine; *P* rests upon the terminal part of the large intestine, the *rectum*, which is laid open below so as to show its cavity, *r* and *r'*, and its contracted termination, the anus, *a*; *S*, symphysis pubis; *b*, bladder; *b'*, outlet of bladder through the urethra, which is very short as compared with that of the male; *u*, the uterus, or womb; *v*, vagina; *h*, hymen; *l*, labium of right side; *n*, nympha of right side; *cl*, clitoris.

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occupy the pelvic cavity, and form the lowest parts of the whole trunk. The urethra in the male is the only channel for the urine as well as the semen; while the uterus of the female is lodged between the bladder and the rectum. This arrangement is offensive and apparently uncalled for; especially since in some animals (*Monotremata, Owen*, 17, 3, 644,) the reproductive outlet is distinct. We must conclude, however, that some deep significance attaches to this association of the organs for the perpetuation of the species with those concerned in eliminating the most poisonous and unpleasant products of the individual.

Viewed from without, there appear two openings; the posterior or dorsal is the rounded outlet of the intestine, and is called the *anus* (*a*); the anterior or ventral is a longitudinal fissure between two fleshy folds, the *labia* (*l*), which, in the adult, are more or less covered by hair; anteriorly these folds unite at a slight elevation, the *mons veneris*, (fig. 13, *mv*). The labia are covered without by the ordinary integument; when separated from each other, the inner or mesial surface of each is seen to present a fold of less extent, and covered by a mucous membrane; these are the *labia minora*, or *nymphæ* (*n*). Anteriorly these unite over a little conical projection, the *clitoris* (*cl*), which is the diminutive representative of the male penis, but is without any canal corresponding to the urethra. The nymphæ and clitoris are very sensi-

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tive and vascular, being capable of erection like the penis.

Behind the clitoris is a small orifice, which leads into the *urethra*, the outlet of the bladder. Still farther back is a larger opening, which in the virgin is usually more or less completely closed by a membraneous fold, the *hymen* (*h*). The presence of the hymen is usually regarded as a sign of virginity, but there are so many cases of its partial or complete absence in virgins, and of its presence with those who have become pregnant, that little importance can be attached to it, (*Napheys*, 46, *149*); when present, it is usually ruptured at the first sexual intercourse. The space between this opening and the anus is the *perinæum*.

Beyond the hymen, the opening leads into the *vagina*, a canal lined by mucous membrane which is thrown into folds so as to permit the great dilatation required in child-birth. There are also in its walls some unstriped or involuntary muscular fibers and loose erectile tissue, which enable the vagina to contract upon the penis during coition. The length of the vagina is from four to six inches, more on the hinder than the anterior wall. Into the upper end of the vagina project the fleshy lips of the *uterus*, or womb. In its undistended state, the uterus has an oblique position, as seen in figure 8; its upper end, or fundus, inclining forward from its vaginal attach-

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ment. It is a pear-shaped organ, flattened from before backward; it is about three inches long, two inches broad at its upper part, and one inch thick. Its walls are thick and consist of unstriped muscular fibers, with a lining of mucous membrane and an outer covering of serous membrane. Its cavity is in two parts, the upper being triangular, and the lower fusiform; this is the *cervix* (fig, 9, *c*). The contracted communication of the cavity of the cervix with that of the uterus proper is called the *os internum*, or inner mouth, while the outer opening into the vagina is the *os externum*.

"In the body of the uterus the mucous membrane is thin, smooth, soft, and of a reddish white color. When viewed with a magnifying glass it is found to be marked with minute dots, which are the orifices of numerous simple tubular glands, somewhat like those of the intestine. Some of these tubular glands are branched, and others are slightly twisted into a coil. The epithelium is columnar and ciliated." (*Quain*, 1, *985*).

The action of the cilia within the tubular glands is such as to carry their secretion to their mouths and leave it as a grayish film lining the cavity of the uterus. The general action of the cilia upon the free surface of the mucous membrane is from without inward, that is, from the cervix toward the fundus and the orifices of the Fallopian tubes. (*Kölliker*, 76, II, *255*).

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FIG. 9.

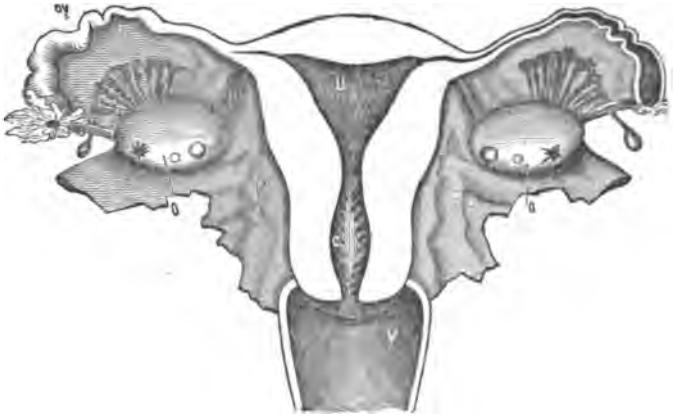

FIG. 9.—The uterus and its appendages, seen from in front. *U*, the cavity of the uterus; *C*, the cavity of its neck, or *cervix*; *V*, the upper end of the vagina; *ov*, the right oviduct, or Fallopian tube; on the left side, this is laid open to show the varying calibre; *oo*, the ovaries connected by a thin membrane, the *broad ligament* with the border of the uterus and of the oviduct. The other structures shown need not be explained in this connection. (From Quain).

The upper angles of the uterus are continued outward as two slender tubes, the *Fallopian tubes*, usually called the *oviducts* in animals. Near the uterus their canal will hardly admit a bristle, but it increases toward the outer end, where, however, it again diminishes to a small circular orifice surrounded by an irregular fringe. The mucous membrane of the Fallopian tubes, of the body of the uterus, and of part of the cervix, is covered with *vibratile cilia*, little hair-like projections, which, by their constant movement, carry

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downward into and through the uterus the *ova* when discharged from the ovary. Even the inner, and, according to Henle (*Quain*, I, II, *992*), the outer, surfaces of the fringes, or *fimbriæ*, are provided with cilia; but the ciliated mucous membrane soon passes by insensible gradations into the serous peritoneum. The orifice of the tube renders the abdomen a technical exception to the rule already mentioned (page 28), that serous cavities are *closed*. But the length of the oviducts and the minuteness of one or both of their orifices, together with the ciliary action of their lining toward the uterus, must usually prevent the access of foreign bodies to the abdomen.

We come now to the essential female organs, the *ovaries*. These, like the testes, are two in number, and in the embryo nearly resemble them, being formed near the kidneys. In the adult each ovary is an oval body about one inch and a half long, placed nearly horizontally, one on each side of the uterus, to which and to the Fallopian tube it is attached by means of a membraneous expansion, the *broad ligament*. From its inner end, too, there passes a twisted cord, the *ligament of the ovary*, which joins the angle formed by the tube with the uterus.

The intimate structure of the ovary is pretty clearly represented by that of the cat (Fig. 10). The attached border (1′) is the point of entrance of vessels and nerves and fibrous tissue. The outer layer (1) was

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FIG. 10.

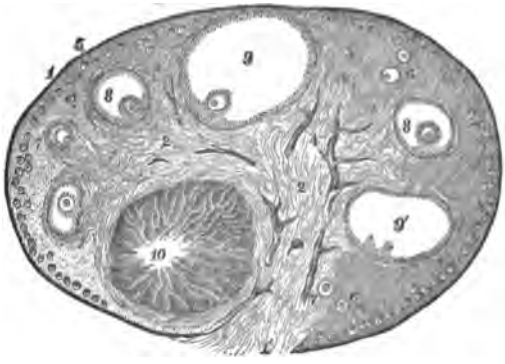


FIG. 10.—Section of the ovary of a cat. (From Schrön, after Quain. 1, *988*). 1, the outer layer (germ epithelium); 1′, the attached border; 2, the tissue of the ovary, presenting a fibrous and vascular structure; 3, granular substance outside the last; 4, blood vessels; 5, ova (eggs) in a very early condition, and lying near the surface; 6, ova larger and more deeply seated; 7, ovum around which the Graafian follicle is visible; 8, more advanced ova in still larger follicles; 9, most advanced follicle, showing the ovum at one side covered by a layer of cells constituting the *proligerous disk*, the rest of the follicle containing a clear fluid; 9′, follicle from which an ovum has accidentally escaped; 10, corpus luteum, presenting a radiate structure.

formerly described as a true serous membrane; but according to Waldeyer and others, (64, *510*,) the peritoneum ceases at a line near the attached border, and the free surface of the ovary is a peculiar cellular layer, the *germ epithelium*, which strongly resembles a mucous membrane; in fact, according to Waldeyer, "in many ovaries the epithelium of the Fallopian tube is continuous with that of the ovary, which only

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lacks the cilia of the former." (64, *510*). The larger part of the ovarian substance consists of connective, fibrous and vascular tissue, with some unstriped muscular fibers; these together constitute the *medullary portion* (2). Outside of this, and forming a granular and cellular layer, is the *cortical substance* (3), in which are seen little sacks or vesicles, named from their discoverer, the Graafian follicles (6). In addition to these, which are readily seen, there are, still nearer the surface, great numbers of similar but smaller follicles, each containing a peculiar cell, the ovum or egg (5). There seems to be some little doubt as to the precise manner and place of origin of these ova and their follicles. But whether, as was formerly believed, they excavate themselves *in* the cortical substance, or whether they are first formed *at* the surface and later sink into the cortical substance, after the manner of hairs, it is generally agreed that the ova are first near the surface (fig. 10, 5); that as they increase and become surrounded by a fluid in a sack (the Graafian follicle), they are more deeply placed (6, 7, 8,); and that still later, when the ovum is ripe, or ready for discharge, the follicle enlarges, the outer wall becomes thinner and finally gives way, allowing the fluid and contained ovum to escape. The manner in which the ovum is received by the Fallopian tube and carried into the uterus will be described farther on. After the escape of the ovum, the follicle

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fills up in such a way as to present a radiated structure called *corpus luteum* (10). The differences between the corpus luteum of menstruation and that of pregnancy are tabulated by Dalton (2, *569*).

When ripe, the human ovum is a spherical body about $\frac{1}{130}$ of an inch in diameter. It has the normal structure of a cell: (1), an outer membrane, here called *zona pellucida*, containing, (2), the yolk, a granular, oily and albuminous substance, "protoplasm"; in this yolk are seen, (3), a smaller vesicle, the germinal vesicle (nucleus), and this again contains (4) the germinal dot (nucleolus): the ovum will be described and figured farther on.

The *mammæ*, breasts or mammary glands, are, like the uterus, accessory reproductive organs, whose office is to secrete from the blood a fluid, the milk, for the nourishment of the young after birth. They appear to be essentially a peculiar modification of the so-called "sebaceous glands" of the skin. In one form or another the mammæ occur with all the animals which have warm blood, bring forth their young alive and nourish them with milk; these animals are hence called *mammals*, as contradistinguished from birds, reptiles and fishes. The form and number and position of the mammæ vary greatly in different groups. The "duck-bill" of Australia (*Ornithorhynchus paradoxus*) presents a mere surface, uncovered by hair, upon which open the little pores or



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outlets of the milk-ducts. In the *Echidna* of the same land, this surface is inverted as a small pouch. In the opossums and most other marsupials we first find *nipples*, which form a group usually covered by a pouch (*marsupium*), into which the young are received after their first birth and retained until able to shift for themselves. In whales the nipples are close to the vulva. In horses and cows they exist upon the hinder part of the abdomen only. With pigs, cats and dogs, there are several pairs in two rows nearly the whole length of the body. In bats and monkeys a single pair occupy the chest, as in human beings. They are rudimentary in the male mammal, although a few cases are recorded of their secreting a milky fluid, capable of nourishing infants.*

In the adult female the human mamma is a hemispherical eminence, which, in those who have never borne children, is usually firm,† and bears the nipple upon its most prominent point. But after the nursing of one or more children it becomes flabby and dependent; the areola surrounding the nipple is also darker.

* Flint, Physiology of Man, Nutrition, Secretion and Excretion, p. 73. Mention is here made of anomalies in number and position of these glands; to which may be added that recorded by Dr. Pineo, Proc. Boston Soc. Nat. Hist., X, *240*, Dec. 6th, 1865.

† It cannot be denied that among our native American women, the cases in which there is more or less deficiency in this organ are very numerous; something will be said upon this hereafter.

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FIG. 11.

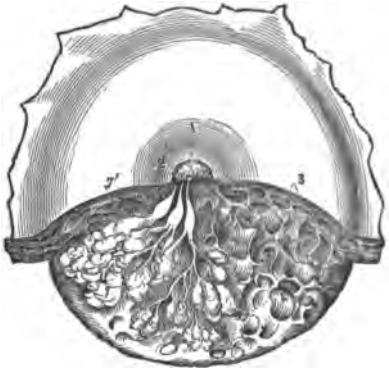

FIG. 11.—Dissection of the lower part of the mamma during lactation. (From Luschka, after Quain, 1, *1003*). 1, the upper part of the nipple, or mamilla; 2, the areola; 3, masses of fat; 4, reticular loculi between the partitions of connective tissue which support the fat and the glandular structure; 5, one of the milk ducts; 6, a milk sinus; 7, some of the lobules which secrete the milk, unraveled.

The structure of the mamma is well shown in figure 11. Upon the surface of the nipple are seen small pores, the orifices of the milk ducts. Following these into the breast itself, they are seen to dilate somewhat so as to form little oblong reservoirs or sinuses, and then to branch in various directions, the finer twigs terminating in small granular masses. These are really minute sacks with very thin walls, capable of taking the elements of the milk from the blood, which is brought to them in minute vessels, and of passing it through the ducts to the sinuses, whence it is ex-

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pelled during nursing, partly by suction and partly by the manipulation to which the infant naturally resorts.

This completes the account of the *structure* of the reproductive organs. We come now to their *functions*.

## PHYSIOLOGY OF REPRODUCTION.

### PUBERTY.*

As already stated, the reproductive organs are formed long before birth, and present definite sexual differences during infancy and childhood. They increase in bulk with the rest of the body, but are not yet capable of performing their peculiar functions. The ovaries contain immature ova, and the testes are gradually preparing to form zoösperms. But in neither sex are the organs fully ready for their work until what is known as the period of *puberty*.

The changes constituting puberty generally occur between the ages of ten and fifteen, the date varying

* While this is passing through the press, comes the sad news of Prof. Wyman's death. Elsewhere (91) has the opportunity been given me for a tribute to my beloved friend and teacher. Of the highest ability and attainment, his modesty was so extreme that he rarely spoke in public and never wrote a popular article. An arbitrator upon all matters within his range of study, he never had a controversy. An ardent collector, he was never suspected of even coveting another's treasures. The acknowledged leader of anatomical science in America, he was ever ready to encourage others in their efforts to rise.

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according to temperament, habits, climate and general conditions. "In both sexes, hair grows on the skin covering the *symphysis pubis*, around the sexual organs and in the axillæ (armpits). In *man* the chest and shoulders broaden, the larynx enlarges and the voice becomes lower in pitch from the elongation of the vocal cords; hair grows upon the chin, upper lip and cheeks, and often exists upon the general surface of the body more abundantly than in woman.

. . . . . The local changes attendant upon puberty in the male are the enlargement of the penis; its more frequent erection; the enlargement of the testes, vesiculæ seminales; prostate gland and other parts; the more dependent condition of the testes in the scrotum; the secretion of the seminal and prostatic fluids; and, after the attainment of full sexual powers, the occasional spontaneous emission of the semen, occurring in general at night during sleep, and accompanied by some sexual feeling in dreams." (*Thomson*, 34, *439*).

"In *woman* the pelvis and abdomen enlarge, but the whole frame remains more slender, the muscles and joints less prominent, the limbs more rounded and tapering. Locally, both external and internal organs undergo a considerable and rapid enlargement. The mons veneris and labia majora become more full; the clitoris and nymphæ generally become erectile; the mammæ enlarge, the ovarian vesicles become di-

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lated, and there is established a periodical discharge of one or more ova, accompanied in most cases by a sanguineous fluid from the cavity of the uterus."

The fact that these extraordinary *functional* manifestations occur, as it were, suddenly, and that any derangement of them is apt to be attended with serious local and general disorder, has perhaps led medical men as well as parents and instructors to give more heed to the hygienic conditions of those under their charge, especially young women, at this period than at others. In a recent article (74), Dr. Van de Warker expresses his conviction that this attention is disproportionate to that which is paid to the earlier and developing periods of childhood and early youth; and is inclined to think that many, if not most, of the weaknesses and diseases which afflict women *after* puberty (and upon which the opponents of coeducation of the sexes have based a strong argument), have had their cause and origin in faulty conditions at an earlier age. But if he is correct, he would not advocate less care at and after puberty; the rather more at all times, and from the very beginning.

## OVULATION.

The sanguineous flow above mentioned constitutes *menstruation*, and will be more fully described here-

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after. It seems to occur only in the human female, and in the apes and monkeys (the *Quadrumana*), but the discharge of the ova—which is called *ovulation*—takes place in all vertebrates, although under very different circumstances in different groups. With most fishes the ovaries are hollow, and communicate with the exterior by a tube continued backward to the vent. In others, as the lamprey (*Petromyzon*), the common eel (*Anguilla*), and the salmon, the ovaries are solid and the ova are set free from the outer surface to find their way out of the abdomen through openings near the vent—the "abdominal pores." In others again, as the sharks and skates and the batrachians (frogs, salamanders, etc.), the outlets are tubes, the *oviducts*, which extend the whole length of the abdomen, and either open separately, one upon each side near the heart, or unite upon the middle line into a single orifice, into which all the ova somehow find their way, and are then carried by ciliary or muscular action backward to the vent. But with reptiles, birds and mammals, the mouth of the oviduct is loosely attached to the ovary, so that the transfer of the ovum into the oviduct is, at least apparently, easier than in some of the lower vertebrates. Still, as this transfer has never been actually witnessed, we are obliged to infer its nature from the anatomical relations of the parts, and these seem capable of two interpretations. The former and still prevalent view is, that at

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the time of the discharge of the ovum, there occurs an erection, or turgescence, of the fimbriated *ostium* of the oviduct, and that this is then closely applied upon the ovary so as to cover the point of rupture of the Graafian vesicle; the accompanying fluid, aided by the cilia of the oviduct, would then ensure the passage of the ovum toward the uterus.

The other and more recent view is stated as follows by Flint, who inclines to it as the more probable. It must be borne in mind, however, that at present this applies only to the human species or to those animals in which has been demonstrated a similar connection between the ovary and oviduct.

"One of the fimbriæ, longer than the others, is attached to the outer angle of the ovary, and presents a little furrow or gutter leading to the opening of the tube. This furrow is lined by ciliated epithelium, as, indeed, is the mucous membrane of all the fimbriæ, the movements of which produce a current in the direction of the opening, which we might suppose would be sufficient to carry a little globule, only $\frac{1}{130}$ of an inch in diameter, into the tube. At the same time, as has been suggested by Becker, there is probably a constant flow of liquid over the ovarian surface, directed by the ciliary current toward the tube; and when the liquid of the ruptured follicle is discharged, this, with the ovum, takes the same course." (*Flint*, 90, *298*).

Sometimes it happens that the ovum fails to enter

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the oviduct, and may nevertheless have been reached by zoösperms which have made their way up from the uterus. In these cases, the ovum may affix itself to the abdominal wall and undergo partial development, constituting "abdominal pregnancy."*

In most mammals the ova seem to establish themselves at various points in the enlarged oviducts which constitute the larger portion of the uterine cavity. But in the human species the normal place of lodgment is in the single cavity formed by the union of the two Müllerian ducts, and it is therefore an exception and a serious accident when an ovum begins its development at any point within the Fallopian tube.

As already stated, ovulation occurs periodically in all mammals, and it is accompanied by a peculiar excitement of the general system, and in some species by a congestion of the whole reproductive apparatus. This condition is known as the "œstrus," or "heat," or the "rut," and, as a rule, it is only at these times or just after them that beasts evince either desire or capacity for intercourse. The duration of the œstrus and of the interœstrual periods varies greatly in different species.

In the human female ovulation generally occurs at

*Mr. J. P. Squires, of Cambridge, Mass., presented to me a mass taken from the abdominal cavity of a sow. It weighs about two pounds, and plainly presents the head and limbs of a fœtal pig, far advanced in development. Such accidents occasionally befall the human ovum.

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regular intervals of four weeks, or a lunar month. But occasionally (as in two cases recorded in 57, IV, *71*,) ovulation may occur regularly upon the same day of the month, that is, at intervals of a *calendar* month; and in one of these the period of gestation was ten calendar months less two days. (57, V, *224*).

## MENSTRUATION.

Ovulation is, in all cases, the *essential* sign that the woman is capable of child-bearing. But since the small size of the ovum renders it difficult to detect, and since the periodical ovulation is nearly always accompanied by the sanguineous discharge above mentioned, this latter is generally taken alone as marking the period. It appears that ovulation may, in rare cases, be unaccompanied by menstruation, and in one instance menstruation occurred after the removal of both ovaries (double ovariotomy). [See a paper by Dr. E. W. Jenks, Trans. State Med. Soc. of Michigan, 1870, p. 138]. Menstruation may also be *vicarious;* that is, performed through other than the proper organs, as the mammary glands. [For such an instance see N. Y. Med. Journ., Aug., 1872, p. 75].

The menstrual flow is also known by the various names, *menses*, *catamenia*, and *flowers;* while the process and the condition superinduced by it are known

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as *menstruation*, the ***monthly sickness***, ***being unwell***, the *period*, etc.

"When this period approaches, the woman experiences a certain degree of discomfort and lassitude, a sense of weight in the pelvis, and more or less disinclination to society. These symptoms are more or less pronounced and troublesome with different individuals. An unusual discharge of vaginal mucous then commences, which soon becomes yellowish or rusty brown in color, from the admixture of a certain proportion of blood, and by the third day the discharge has the appearance of nearly pure blood The unpleasant sensations then usually subside, and the discharge gradually ceases; its color changes from a pure red to a brownish or rusty tinge, until it finally disappears altogether, and the woman regains her ordinary condition." (*Dalton*, 2, *555*).

"Excepting the periods of gestation and lactation, the menstrual periods usually recur as above stated until about the forty-fifth year,* when the periods first become irregular, and then cease altogether. Their final disappearance is an indication that the woman is no longer fertile and that pregnancy cannot again take place." (*Dalton*, 2, *555*). The liability to certain local and general, even mental, derangements, renders this a critical period in life.

*Some remarkable exceptions to this are recorded, as of child-birth at the ages of fifty-one and fifty-three years. (N. Y. Med. Jour., Oct., 1872. p. 430).

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*Amount of menstrual fluid.* This varies greatly with different individuals and in different states of health. "The average quantity in temperate climates is reckoned at six to eight ounces. I am of opinion that all beyond two or three ounces should be regarded as abnormal in quantity; for all the individuals who lose unusually small quantities have enjoyed unusually good health." (*Trall*).

"But even if the quantity of fluid escaping at each recurrence of menstruation be estimated at only three ounces, . . . and the process be repeated without interruption thirteen times annually for thirty years, then there will have passed from the system an aggregate quantity of *seventy-two pounds*, or *nine gallons*, which, so far as it is composed of blood, will have been apparently wasted." (*Farre*, 65, *670*).

*Sources of the menstrual fluid.* "The blood which escapes during the menstrual flow is supplied by the uterine mucous membrane; it is discharged by a kind of capillary hemorrhage, similar to that which takes place from the lungs in cases of hemoptysis, only less sudden and violent. The blood does not form any visible coagulum, owing to its being gradually exuded from many minute points and mingled with a large quantity of mucus. But when the amount is abnormally great, it coagulates in the same manner as if derived from any other source."* (*Dalton*, 2, *559*).

* For a synopsis of the various opinions respecting the exact mechanism of the discharge, see 65, *665*.

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The duration of the menstrual flow seems to be quite variable, but to be rarely less than three days, or more than eight.

*The Purpose of Menstruation.* No satisfactory explanation has, as yet, been offered. Certain facts in Comparative Anatomy and Physiology have led me to entertain a new view of its purpose, but I am not yet ready to publish it.

## HYGIENE OF MENSTRUATION.

"In the first place it is necessary to take great care to *avoid taking cold* during the catamenial period, and for a few days previous to it; nothing is more sure to arrest or disturb the flow of the menses than a sudden chilling of the general surface of the body, especially while in perspiration either from violent exercise, from sitting in over-heated rooms, or from other causes. By this it is not meant that exposure to the weather, even though it be cold and stormy, is necessarily injurious; on the contrary, it is far better that the healthy woman should at this, as at other times, take judicious out-door exercise, whatever be the condition of the weather; but it is highly important to guard, by sufficient clothing of the right kind, judiciously distributed over the body, against taking cold during such exposure.

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'It is also necessary to refrain from bathing during this period.*

"It is necessary to refrain at this time from prolonged violent exercise of the body; and it is highly important to keep the bowels and kidneys in normal action: neglect of this last is a fruitful source of female diseases.

"But the influence of the spirit upon the body is not to be neglected in this relation. Many a dyspeptic owes half his troubles to that mysterious power of the spirit over the physical frame, whereby moodily brooding over a supposed ill induces the evil itself. It cannot be too strongly urged that the young woman should avoid watching with ignorant and distressing anxiety the symptoms of the first approach and the subsequent recurrence of menstruation. This anxious watching of symptoms may either induce a morbid condition, or may greatly aggravate an existing tendency to such a condition.

"Under this head may be mentioned the evil consequences that may follow violent excitement, or agitation of the mind, especially of the moral feelings. A violent fit of anger, great depression of spirits, continued anxiety or fear, sudden alarm, excessive joy or hilarity, may check or arrest the menses as effectually as

*It is presumed that reference is here made to the cold or shower-bath, by which a sudden or violent shock is produced.

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the catching of a violent cold. Excessive and prolonged taxation of the mental powers, especially if attended by anxiety and agitation of mind, may also prove injurious. This does not refer to ordinary, judicious study, such as is necessary for the average student to pursue successfully the curriculum of the best seminaries, colleges and professional schools.* If the student is driven by an impetuous, uncurbed ambition and a foolish desire to outrank others of better mental powers or of better preliminary preparation, the result will doubtless be a derangement of this and many other, if not of all other, functions of the physical system.

Where local disease exists, the patient should consult a physician, just as for inflammation of the lungs, or for any disease of any other organ."

*This is a point upon which there is, at present, a division of opinion, both medical and public. The other view of the case has been forcibly presented by one of the ablest of living physicians. Dr. Clarke (60, *156*) holds that the girl should spend in study one or two hours less time daily than a boy; also that during every fourth week there should be a remission, and sometimes an intermission, of both study and exercise. See also Holmes, (111).

Upon these points I am not, as yet, able to form an opinion from personal observation. But I am inclined to think that the true relation between woman's education and her health can best be determined by careful, impartial and long-continued observation of young women who commence their higher education in good health. Perhaps the discussion will have the effect of showing that with the young of both sexes too much time is spent in study. (See also page 54).

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"And here we may add, in passing, that if there were an accomplished and experienced lady physician within the reach of every young woman, whether at school or not, probably ten times the number would secure special medical aid as now do; for it does take some courage, not to use a stronger term, for a girl or a young woman to lay her troubles before a physician of the other sex." (*Comfort*, 89, *61-64*).

I think that more stress may advantageously be placed upon one of the above hints, and as regards both sexes and at all times, although women are naturally more often obliged to defer the natural operations beyond their proper period. The famous Dutch physician Boerhaave had an elegantly bound book in which, as he said, were written all the secrets of physic. Upon examination, after his death, there were found the following sentences: "Keep the head cool, the feet warm and the bowels open."

With most persons there is a natural desire to relieve the bowels soon after breakfast. But, with students especially, the duty is apt to be deferred for lack of time, and perhaps neglected until the next day. Aside from the discomfort, and the heavy feeling which more or less interferes with mental activity, this irregularity is very apt to induce habitual constipation. For this trouble, as for most others, the average American takes a dose of some laxative, or perhaps jeopards his health by the use of some of the ad-

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vertised "pills." The temporary relief is very often followed by an even more obstinate constipation, and by degrees the result of inattention may be a serious derangement of one of the most important bodily functions.

Before running any such risk, it may be well to try the following plan:

First, let nothing less than a serious emergency interfere with daily and regular attempts at alvine evacuation.

Second, in case of constipation, eat more laxative food (as oatmeal, cracked wheat and the like, fruit and vegetables); drink more water than usual, and take more exercise; these will usually accomplish the desired result in a few days, and without the disturbance occasioned by drugs.

Third, in case of chronic constipation, in addition to the above regimen, relief may be gained by what is known as "kneading the bowels;" that is, repeatedly raising the lower part of the abdomen with the hands, and letting go suddenly. The effects are much the same as those of horse-back riding, and persons have been relieved by it, not only from constipation, but from that kind of indigestion which is apt to attend sedentary habits of life. In very obstinate or painful cases, of course medical advice should be obtained.

*Injurious modes of dressing.* Upon this subject Prof. Thomas writes as follows (94):



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"The dress adopted by the women of our times may be very graceful and becoming, it may possess the great advantages of developing the beauties of the figure, and concealing its defects, but it certainly is conducive to the development of uterine diseases, and proves not merely a predisposing but an exciting cause of them. For the proper performance of the functions of respiration, an entire freedom of action should be given to the chest, and more especially is this needed at the base of the thorax, opposite the attachment of the important respiratory muscle, the diaphragm. The habit of contracting the body at the waist by tight clothing confines this part as if by splints; indeed, it accomplishes just what the surgeon does who bandages the chest for a fractured rib, with the intent of limiting thoracic and substituting abdominal respiration.

"As the diaphragm, thus fettered, contracts, all lateral expansion being prevented, it presses the intestines upon the movable uterus, and forces this organ down upon the floor of the pelvis, or lays it across it. In addition to the force thus excited, a number of pounds, say five to ten, are bound around the contracted waist, and held up by the hips and the abdominal walls, which are rendered protuberant by the compression alluded to. The uterus is exposed to this downward pressure for fourteen hours out of every twenty-four; at stated intervals being still further pressed upon by a distended stomach.

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"No one will charge me with drawing upon my imagination, even in the remotest degree, for the details of the following picture, for a little reflection will assure all of its correctness. A lady who has habitually dressed as already described prepares for a ball by increasing all the evil influences which result from pressure. Although she may be menstruating, she dances until a late hour of the night, or rather an early hour in the morning. She then eats a hearty supper, passes out into the inclement air, and rides a long distance to her home. This is repeated frequently during each season, until advancing age or the occurrence of disease puts an end to the process.

"A great deal of exposure is likewise entailed upon women by the uncovered state of the lower extremities. The body is covered, but under the skirts sweeps a chilling blast, and from the wet earth rises a moist vapor that comes in contact with limbs encased in thin cotton cloth, which is entirely inadequate for protection. It is not surprising that evil often results to a menstruating woman thus constantly exposed."

Prof. Thomas advises that in cold weather the feet, legs and abdomen of women be clad in some woolen material. He thinks that this and the other reforms indicated "would likely bring forth results in one generation, but it would probably require many generations to restore woman to her proper physical sphere."

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A more specific charge is made by Dr. E. Cutter. "There is no doubt in my own mind that the present mode of suspending the dress of females from the waist is a prominent cause of uterine displacements. First, there is the corset surrounding the waist; even if worn loosely, it none the less communicates the superincumbent weight of garments to the abdominal region, and crowds the viscera down to the lower part of the cavity in the pelvis. The natural points for suspending the garments, in men and women, are the shoulders." "The person who will invent a means of suspending the garments of women from the shoulders which shall combine ease, lightness and mechanical adaptation will deserve the reward of a benefactor." (57, V, *295*).

For some practical suggestions upon this subject, the reader is referred to recent works, (95 and 103). With most women the shoulders slope so much as to render anything like "suspenders" inconvenient. But the skirts may be buttoned upon a "waist" which gets its support from the shoulders.

Perhaps the result of the agitation will be the gradual adoption of a style of dress which shall be free from the unhealthy and improper features of the present fashions, while avoiding the the impracticable extremes of the reformers. If the dressmakers would combine physiology with tastefulness, they could probably accomplish more in a quiet way than all the books and lectures upon Dress Reform.

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## FECUNDATION.

The development of ova and of zoösperms characterizes the mature* period of life with human beings and with most animals in which the sexes are distinct.

In order that a new individual shall be evolved, these two kinds of generative products must meet and, it seems probable, be incorporated with each other. This union causes the ovum to take on a peculiar development, and it is then said to be *fecundated*, or *fertilized* or *impregnated*.

Before describing the fecundation of the human ovum I shall present a synopsis of a remarkable paper (100) recently published by Prof. Van Beneden, of Liége, upon the development of the reproductive organs in certain Hydroid polyps, and upon the general nature of fecundation.† To many of my readers his statements and conclusions may be difficult of comprehension, and some of them may prove to be incorrect. But there is sufficient coincidence with the results of other investigations to warrant their presentation in this connection.

According to most zoölogists the Hydroids consti-

*In at least two species of Batrachians (*Siredon Mexicanus* and *S. lichenoides*) the immature or larval form seems to be endowed with reproductive powers. (Marsh, Am. Journal of Science, Nov., 1868: "On the Metamorphosis of *Siredon* into *Amblystoma*).

†A translation of Van Beneden's "Introduction" and "Conclusions" is given in the American Naturalist for Dec., 1874.

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tute the lowest order of the class Acalephs, which also includes the other radiated animals known as Jelly-fishes and Medusæ. By Agassiz, by Alex. Agassiz and by others the Acalephs are regarded as one of the three classes of the Radiate branch or subkingdom; but most European naturalists are inclined to follow Leuckart in separating the true Polyps (coral-makers) and the Acalephs from the Echinoderms (Sea-urchins and Star-fishes), as a distinct group, the Cœlenterata.

"The Hydroids include all those Acalephs which either pass the earlier stages of their existence as little shrub-like communities, or remain in that condition through life. These hydroid stocks, as they are sometimes called, give rise to buds; these buds are transformed into jelly-fishes, which in some instances break off when mature, and swim away as free animals, while in others they remain permanent members of the hydroid stock, never assuming a free mode of life. All these buds, when mature, whether free or fixed, lay eggs in their turn, from which a fresh stock arises to renew this singular cycle of growth known as 'alternate generation.'" (*E. C.* and *A. Agassiz*, 69, *21*).

The difference between this kind of parthenogenesis and that of the Aphides is that in the Hydroid the buds are external, while in the plant-lice they are internal. Both finally produce ova.

In his admirable manual of Animal Physiology (101) Prof. Cleland makes the same comparison between the

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bud and the ovum that was suggested on page 18. He says (p. *273*), "If the bud happen to be only a single nucleated corpuscle devoted to reproduction, separated from a large mass of such corpuscles or from an organism however complex, yet it is plain that it may be none the less fairly considered as a bud or germ from the whole organism. Now that is precisely what an ovum essentially is; but an ovum, whether animal or vegetable, has the peculiarity that it will not develop into a new individual unless there be incorporated with it another germ of dissimilar kind, though derived from the same species of organism, and herein consists the essence of sexual reproduction (gamogenesis)."

The Hydroids observed by Van Beneden were of the species *Hydractinia echinata*. The American species, *H. polyclina*, has been studied by Agassiz, and is described and figured by him (71, III and IV) and by Mrs. E. C. and Alex. Agassiz (69). But as there is no great difference in their habits, I will translate from Van Beneden's account of the European species:

"The Hydractiniæ live in numerous colonies, upon various species of univalve (gasteropod) shells, *Buccinum*, *Natica*, etc., which have lost their original inhabitants and have been occupied by 'hermit' or 'soldier-crabs' (*Pagurus*).

"Like all other Hydroids, these colonies are *polymorphous*; that is, they are composed of three kinds

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FIG. 12.

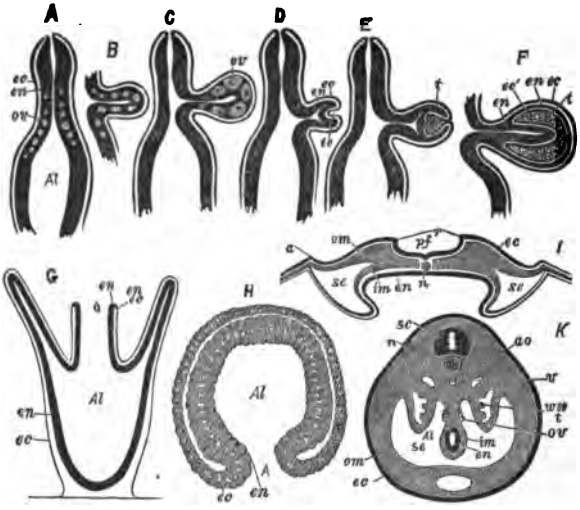


FIG. 12.—Diagrams intended to illustrate the views of Van Beneden respecting the origin of the ovaries and testes. A—F, diagrammatized versions of Van Beneden's figures and descriptions; H, from Kowalewsky; I, from Remak, after Haeckel (104, Fig. 85); K, from Waldeyer, after Haeckel (104, Fig. 200), slightly altered. The following lettering applies to all the figures: *ec*, ectoderm; *en*, entoderm; *Al*, alimentary canal, or gastric cavity; *A*, anus; *ov*, ovary; *t*, testes; *W* or *t*, Wolffian body or testis; *pf*, primitive furrow; *r*, dorsal ridges; *om*, outer layer of the middle germ layer or mesoblast; *im*, inner layer of the mesoblast; *n*, notochord; *se*, serous or pleuroperitoneal cavity, "coelum" of Haeckel; *ao*, aorta; *o*, oral opening or mouth. G, vertical section of a Hydroid. The outer sack or ectoderm is represented by the thinner line; the inner and thicker line represents the entoderm, enclosing the gastric cavity. The two layers are connected with each other at the margin of the mouth *o*, and are continued up into the tentacles surrounding the mouth. A—F, reproductive regions of the Hydroid investigated by Van Beneden (*Hydractinia echinata*). A, upper part of a female individual, with partly developed eggs in the entoderm at the junction of the neck with

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the gastric region. B, a bud from one wall of the same, showing an increase in the size of the eggs. C, the same at a later stage, the ovarian bud or *sporosac* containing fully formed ova in the entoderm. D, a male *Hydractinia;* the male sporosac developing from one side, has its extremity involuted. E, the same at a later stage. The sporosac is larger, the depression upon its end has been nearly enclosed by the rising of the parts about it, and in the cavity thus formed is developed the testis *t*. F, the same sporosac still more developed; the approximated ridges have fused and become continuous; the testis is enveloped by the involuted portion of ectoderm, *ec'*, outside of which is the non-involuted entoderm. In the original figures a rudimentary testis is shown in the female sporosac, and rudimentary eggs are shown in the male, Van Beneden having found that both sexes are hermaphroditic. H, embryo of *Amphioxus* at about the tenth hour of development. The hollow sphere formed by the segmentation of the ovum has one side pushed in against the other so as to obliterate the primitive cavity and give rise to a secondary cavity, which is to become the alimentary canal. The constricted opening becomes the anus. In this stage the lowest Vertebrate corresponds to the adult Hydroid in consisting of a sack with a double wall of cells. Both are by Haeckel regarded as derivatives of the primordial *gastrula* form. I, cross-section of an embryo chick, showing the four secondary layers of the blastoderm (See page 111). The dorsal ridges (*r*) have not yet met over the primitive furrow (*pf*), and the spinal cord is not yet formed. Between the outer layer (*ec*) and the inner layer (*en*) is a thick layer, the mesoblast or middle germinative layer, at the expense of which are thought to be developed the muscular and osseous systems. On each side of the notochord (*n*) the mesoblast is in two layers, of which the outer (*om*) is adjoined to the ectoderm. The inner (*im*) unites with the entoderm to form the walls of the alimentary canal. The space between them (*se*) is the abdominal cavity or *coelum*. K, cross-section of embryo chick at the fourth day, magnified about 40 diameters. The dorsal ridges have met and coalesced, and the spinal cord is formed. The abdominal walls have been completed by the meeting of the borders of the blastoderm. The darker lines *ec* and *en* still designate the ectoderm and entoderm, but the bulk of the body is formed by the enlarged middle layer. The Wolffian bodies are in the abdomen, but are supposed to have come from without, from the ectoderm, by a process of involution of which Haeckel gives diagrams (104, Fig. 48). The ovaries are not represented by him or by Waldeyer, but I have introduced them, one on each side, to indicate their *supposed* origin from the entoderm, in Vertebrates as well as in Hydroids.

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of individuals." According to Agassiz and Wright there are four forms, but we are here concerned only with the individuals which manifest sexual peculiarities, and which Van Beneden calls "*gonosomas*."

"The Hydractiniæ are *diœcious*. All the reproductive individuals of the same colony are of the same sex." "The female colonies (Fig. 12, A) may be recognized with great ease. The yolks of the eggs are of a beautiful red. . . The testes, on the contrary, are milky white." "As in all Hydroids, the entire body consists of two layers, which are continuous with one another at the border of the mouth. Each layer is composed of a single series of cells. The outer layer is called the *ectoderm* (*ec*), the inner the *entoderm* (*en*). Between these two layers is a structureless membrane." (This is not represented in the figures). From the side of the body, in what is called the germinative region, are protruded little diverticula, or sacks, which, like the stem, consist of the two coats, entoderm and ectoderm. These are called by Van Beneden "gonophores," or, more often, "sporosacs." And they proceed in the male to develop the testes and zoösperms, and in the females the ovaries and ova.

"*Conclusions.* In the Hydractiniæ 1. The eggs are developed exclusively from the epithelial cellules of the entoderm. They remain, up to the time of their maturity, surrounded by the elements of the entoderm.

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2. The testicles and spermatozoa are developed from the ectoderm; this organ results from the progressive transformation of a primitive cellular fold formed by invagination.

"3. There exists in the female sporosac a rudiment of the testicular organ; in the male sporosac a rudimentary ovary. The sporosacs are then morphologically hermaphrodites."*

The technical account of the way in which these parts are developed may be better comprehended by a familiar illustration.

A mitten of leather, lined with cloth, may represent the body of the Hydroid. The leather is the ectoderm, and the cloth the entoderm. Suppose its open end to be closed, and attached to the earth, and a smaller opening to be cut in its other, or finger end. At the margins of this hole the leather and the lining are so joined as to be continuous.

With the sterile Hydroids, and with certain regions of the fertile ones, the function of the ectoderm is to enclose and protect the entoderm, which, in its turn, merely digests and absorbs the food which is received by the single orifice.

*In the Hydroids, then, the testis and ovary are not identical organs, since they coexist in the same individual. And if in Vertebrates they can be shown to be formed from different layers, we must admit that they are different organs, even although so few cases have been observed of their coexistence in the same animal.

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Now the thumb may represent a single *sporosac.* Like the rest of the mitten, it is leather outside and cloth within. Then, in place of its ordinary functions, if the sporosac is female, the cloth thickens and produces the ova. But if it is male, there occurs at the tip of the thumb a hollowing in, by which a cavity is formed, at first shallow, then deeper and deeper, until at last it is wholly enclosed. But its lining is formed by the leather (ectoderm), and does not communicate with the true internal cavity. In this secondary cavity are developed the testis and the zoösperms.

Now Van Beneden has found that in the female sporosac there is also developed a slight cavity at the tip, and that a rudimentary testis is there formed; while in the male sporosac the entoderm thickens slightly and develops a rudimentary ovary.

"The entoderm and ectoderm have, from a sexual point of view, an opposite signification. If it is true that the organs form themselves by anatomical differentiation, according to a division of physiological work, we must admit that primitively the ectoderm is wholly charged with the masculine function, and that the entoderm fulfils the female function.

"If the entoderm can be called the animal layer (nervous and muscular) because the cells of the epidermis, of the nervous system and of the muscular system result from a progressive differentiation of the cells of the ectoderm, that layer should also be termed

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the masculine layer. The entoderm is the female layer, and likewise the vegetative layer (the layer of organic life).

"Fecundation consists in the union of an egg, a product of the entoderm, with a certain number of spermatozoa, products of the ectoderm. This act has no other end than to unite chemical elements of opposite chemical polarity, which, after having been united an instant in the egg, separate again; for in most animals, those in which the division of the vitellus into two occurs, the elements from which the ectoderm is formed are already separated from those which are to form the internal layer of the embryo.

"The new individuality is realized at the instant when the union between the elements of opposed polarity has taken place, as absolutely as a molecule of water is formed by the union of atoms of hydrogen and oxygen."

The possible relation of this discovery respecting the Hydroids to the reproductive organs and functions with other animals is indicated by Van Beneden in the following paragraphs:

"All the pluricellular animals,* in which the development begins by the segmentation of the cell-egg, pass through in the course of their evolution a similar em-

*This term includes Radiates, Mollusks, Articulates and Vertebrates; they are also sometimes spoken of collectively as the Metazoa, in contradistinction to the Protozoa, or *one-celled* animals.

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bryonic form, that of a sack whose thin walls are constituted of two adjacent layers; the entoderm and ectoderm. The first surrounds a cavity which is the primordial digestive tube; the second limits exteriorly the body of the embryo; it alone can be impressed by external causes. The digestive cavity communicates with a single orifice, which serves as both mouth and anus; the embryo is reduced to a digestive cavity, which is but a simple stomach. Haeckel has proposed to give to this primordial form the name of *gastrula*. As this embryonic form occurs in the Vertebrates, as well as the Mollusks, Arthropods, Echinoderms, Worms and Polypes, it is clear that the ectoderm is homologous in the different types of organization; that the entoderm has in all the same morphological value; that the primordial digestive cavity of vertebrates and that of all other types of organization have the same anatomical signification."

"It follows, from all the embryological observations upon vertebrates, that the middle layer* of Von Baër and Remak gives rise to only the epithelium of the primitive peritoneal cavity. Now, according to the observations of Waldeyer, the superficial epithelium of the ovary of vertebrates is only that part of the peritoneal epithelium which covers the middle plate

*The layers here referred to correspond to the external, internal and middle blastodermic membranes, which may be detected in the early stages of development. (See page 111 and Fig. 12).

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(of Remak). The observations of Götte, of Peremeschko, of Schenk, of Œllacher and Rieneck have demonstrated that the internal layer and the middle layer of Remak are only differentiated parts of one and the same cellular layer (the entoderm), which is derived wholly from the white vitellus of Batrachians. The female sexual epithelium, which persists at the surface of the ovary with mammals, and from which are formed the Graafian vesicles and the ducts of Müller, is derived, then, ultimately from the entoderm.

The testis is formed from the Wolffian duct, according to the observations of Waldeyer and other embryologists. Now His, Hensen and Waldeyer have derived the Wolffian duct from the outer layer (ectoderm) by the intermediation of the axial cord. The testis, then, is, in Vertebrates, derived from the ectodermic layer. My conclusions would then be confirmed as regards the vertebrate branch. The Vertebrates are the only ones in which, in addition to the Zoöphytes (Cœlenterates), the origin of the sexual organs has been ascertained; but it is probable that these results will be verified throughout the animal kingdom."*

As has been pointed out by Alex. Agassiz, (102, *380*), some important qualifications should be made of

* As to the consequent non-identity of ovary and testis, see p. 75, note.

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the foregoing generalization. In the first place, the *gastrula* of Haeckel is identical with the *planula* stage of the Sponges discovered in 1868 by Maclay. Secondly, the *Amphioxus*, the lowest known vertebrate, is the only member of that branch in which a gastrula or planula stage has been seen. And finally, while in Actiniæ, Worms and Hydroids the primitive digestive cavity is hollowed out of the yolk, and has its walls formed by the *entoderm*, in the Echinoderms and in most of the Acalephs (namely, the Ctenophoræ and some Discophoræ) the cavity is formed by the turning in or involution of the *ectoderm*, which therefore forms the walls of the cavity.

A similar difference obtains between the digestive cavity of *Amphioxus* and that of other Vertebrates. In the former alone the gastrula or planula form results from the involution of the single layer of cells which is the result of segmentation, so that a part of this layer forms the wall of the digestive cavity, while in all other Vertebrates, so far as is known, the digestive cavity is hollowed out of the yolk.

In both cases there result an outer and an inner layer of cells, which have been called ectoderm and entoderm. But their manner of formation is not identical; and although Haeckel and Lankester and Van Beneden regard this as no bar to their homology and similar designation, it is claimed by Agassiz that the difference should be taken into account, and that it

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especially militates against the doctrine of descent of all these forms from a common gastrula stock.*

This involves the general question as to the value of the *mode of development* in the determination of homologies, which has been briefly indicated by me in another connection, (32, *229*). Without attempting to decide this matter, I would suggest that if we reject the homology of the inner and outer layers of the embryo *Amphioxus* with those of other vertebrate embryos, upon the ground of a difference in the manner of their formation, we must also deny the homology of the anal openings; for in *Amphioxus* it is the gap left by the involution of the original outer layer, while in Reptiles and Birds it is a secondary perforation of the body-walls.* (*Kowalewsky*, 70, *Huxley*, 63, *107*, and *Balfour*, 107, *337*).

*Arrangements for fecundation.* We are now prepared to study the methods by which fecundation is accomplished among the higher animals. And first it is necessary to enquire into the arrangements for the meeting of the ova and zoösperms. It would carry us too far to enumerate the methods among the lower branches of the animal kingdom, and we will begin therefore with the Vertebrates.

With fishes, as a rule, the sexes do not unite; "the

*For Haeckel's views upon all these subjects, and for a discussion of the bearings of Van Beneden's discovery, see 109 and 104, *660*.



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female seeks a favorable situation for depositing her spawn, usually in shoal water where it can be most influenced by solar warmth and light. The marine herring, mackerel and pilchard approach the shore in shoals; the fluviatile salmon quits the estuary to ascend the river, overcoming, with astonishing perseverance, the rapids or other mechanical difficulties that impede its migration to the shallow sources whither the sexual instinct impels it as the fit place for oviposition." (*Owen*, 17, I, *600*). The ova are discharged, the milt (semen) is likewise scattered broadcast in the water, and such are the numbers of ova* and zoösperms that a sufficient proportion of them meet and fecundation is effected.

But with certain osseous fishes, the Blenny (*Zoarces viviparus*) and a few other genera, the sexes unite by approximation of the vents, so that the semen is received and carried into the female organs, where the ova are impregnated and undergo development.

With some Batrachians, as the frogs, the male mounts the back of the female, and as the ova are expelled they are fertilized by the semen. But with some salamanders there seems to be a close union of the vents; and with *Menobranchus* the male, at the

*In a Lamprey-eel, (*Petromyzon Americanus*), by counting the ova in a small mass, whose weight was known, the total number in the ovary was estimated by me at 236,602. Of some ordinary fishes even higher numbers are given.

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breeding season, presents a kind of vascular fringe around the vent, the purpose of which may be to prevent access of water to the semen.*

With all air-breathing Vertebrates there occurs a union of the sexes. "Treading" and "covering" are common names for the reproductive act with birds and quadrupeds. Unlike other Mammals, the Cetacea (whales and porpoises) and Sirenia (manatee and dugong) are supposed to meet front to front. The same is thought to be the case with the Selachians (sharks, skates and Chimeræ). Now these animals are usually regarded as lower in rank than the ordinary fishes, and their remains occur in the lowest beds where Vertebrates are found. "It is certainly remarkable that among the earliest repre-

*I wish here to call attention to the usefulness of this large Batrachian to the beginner in anatomy. The class is intermediate between the aquatic and the air-breathing Vertebrates. This genus has simple undivided lungs and well-developed external gills, so as to merit, anatomically at least, the name Amphibian. The length of the abdominal cavity renders it easy of general examination. The adult ovaries usually contain eggs of at least three sizes. The oviducts are lined with cilia. The zoösperms are very long, and easily observed in active movement. The red blood-corpuscles are the largest among vertebrate animals. The gill-fringes may be placed under the miscroscope so as to show the circulation through them. The brain is readily exposed; the muscles are easily dissected; the nerve-cells and fibers and the muscular fibers are large. It abounds in the lakes of central New York and westward; it is voracious but harmless, and the flesh is white and well-tasted.

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sentatives of the great type to which man belongs there should have been, as it were, a prefiguration of the human manner of approach."

*The Orgasm and Ejaculation.* At the close of the reproductive act, "the semen is discharged from the urethra with considerable force by spasmodic contractions of the vesiculæ seminales and the ejaculatory muscles." (*Flint*, 90, *335*). This takes place involuntarily, by what is known as a *reflex action* of the spinal cord. This action may be brought about under other than the normal conditions, as in self-pollution; but "an unnatural degree of one kind of excitement is then substituted for what is wanting in another" (*Carpenter*), and the organs and nervous system suffer to a corresponding extent. Many believe that the injury is due merely to the loss of semen. But that this is not the chief cause is shown by the disastrous effects of the above-named habit with females, where the orgasm is not attended with any discharge.

*The Mechanism of Fecundation.* We have already learned (page 49), that the ovum has the usual structure of a cell, namely, protoplasmic contents enclosing a nucleus and nucleolus, and surrounded by a membrane, the vitelline membrane, or, as it is called with Mammals, the *zona pellucida*. (See page 106).

Now there is do doubt but that the fecundation of an ovum requires that a number of zoösperms should come into contact with it. And now the question

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arises whether this mere contact is sufficient, or whether the zoösperms must enter the yolk; and if so, whether they make their way through by a kind of osmotic action, or by means of a special orifice.

It is quite possible that the mechanism of fecundation varies in different animals. "In the ova of *Nephelis*, a small species of leech, Robin has seen spermatozoids, to the number of several hundreds, penetrate the vitelline membrane, always at one point, continuing their movements upon the surface of the vitellus. We had an opportunity of witnessing a demonstration of these phenomena by Prof. Robin, in 1861, in the ova of *Limnæus stagnalis*, and actually saw a zoösperm half way through the vitelline membrane. . . Coste and many other describers, whom it is not necessary to quote, have seen the zoösperms within the vitelline membrane in the ovum of the rabbit; and, more recently, Weil has seen them wedged in the substance of the zona pellucida (vitelline membrane), . . . . and has in some instances seen perfectly formed zoösperms in the very substance of the vitellus." (*Flint*, 90, *352*).

Now with some mollusks and with many osseous fishes (stickleback, trout, etc.) there exists a distinct funnel-shaped perforation of the vitelline membrane, called the *micropyle* (figured in 66, *101*).

But no actual openings have been seen in the vitelline membrane of the mammalian ovum, and although

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analogy might dispose us to anticipate their discovery, yet the experiments of Lott, referred to by Flint, (90, *353*), suggest that the passage of zoösperms through an animal membrane may be effected in the absence of any orifices.

*Nature of Fecundation.* "We do not know what becomes of the zoösperms after they have come in contact with the vitellus. All that we can say upon this point is that there is probably a molecular union between the two generative elements." (*Flint*, 90, *353*).

Without entering into details of the diverse theories which have been offered respecting the precise nature of the action of the zoösperms upon the ovum, there can be no doubt of the following:

1. That with man and the higher animals the contact of the two elements is essential to the preservation and development of the ovum.

2. That the contact occasions a peculiar action of the ovum,—*segmentation*,—whereby it becomes fit for further development.

3. That the *permanent* physical, mental and moral attributes of both parents* may be and generally are

* "No definite rule can be laid down with regard to the transmission of mental or physical peculiarities to offspring. Sometimes the progeny assumes more the character of the male than of the female parent, and sometimes the reverse is the case, without reference to the sex of the child; sometimes there appears to be no such relation; and occasionally we note

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implanted in these minute reproductive products, although in man the ovum is less than one hundredth of an inch in diameter, and the zoösperms less than one four-hundredth of an inch in length.

4. That in many cases the physical, mental and moral conditions of the parents *at the time of coition* have been impressed upon the reproductive products.

*Gestation.* With most Fishes, Batrachians and Reptiles, and with all Birds,* the ova are discharged ("laid") by the female either before fecundation, or during or after coition, when that occurs.

These vertebrates are hence called *oviparous;* and with them, as a rule, there is no further bodily connection of the young with the parent. To this rule there are, however, some striking exceptions, several of

peculiarities derived apparently from grandparents. This is true with regard to pathological as well as physiological peculiarities, as in inherited tendencies to certain diseases, malformations, etc." (*Flint*, 90, *346*). Dr. J. Stockton-Hough has recently discussed this important subject in an exceedingly suggestive manner, (90).

* Dr. Frank Wells, of Cleveland, Ohio, has kindly placed in my hands, for investigation, a body taken from a hen which, for no apparent cause, suddenly ceased to lay eggs. It is about the size of a newly-hatched chick. It has a distinct head, but the neck is short, and the body is nearly oval, without limbs or feathers. The skull contains a brain, and viscera are recognizable. Upon the end farthest from the head are grouped numerous yellow ova, from one-sixteenth to one-fourth of an inch in diameter. It will be fully described and figured hereafter. I merely mention it here as a case of exceptional development of a bird within the parent.

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which have been described and illustrated by Professor Wyman (4, 29, 62). Some of these "unusual modes of gestation" present a very peculiar feature, namely that of the *male playing the part of nurse.* For instance, the male of the "obstetric toad" of Europe (*Alytes*) attaches the eggs to his legs and takes care of them until they hatch.*

With certain South American fishes of the genera *Bagrus* and *Arius*, the male carries the eggs, (twenty or thirty in number), in his *mouth* until some time after the young are hatched. Prof. Wyman figures one young fish from the mouth of *Bagrus*, nearly three inches long, and says: "The question will be very naturally asked how, under such circumstances, these fishes are able to secure and swallow their food. Unless the food consists of very minute particles, it would seem necessary that during the time of feeding the eggs should be disgorged. . . . In the mass of eggs with which the mouth is filled, I have occasionally found the eggs, rarely more than one or two, of another species. The only way in which their presence may be accounted for, it seems to me, is by the supposition that while feeding the eggs are disgorged, and as these fishes are gregarious in their habits, when the ova are recovered, the stray egg of

*According to some authors, the eggs are wound about his legs in strings.

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another species may be introduced into the mouth among those which naturally belong there"; (Wyman, 29, *13*). Upon the mouth gestation of *Arius Boakei*, see Turner (8, *109*).

The males of the "pipe-fishes" (*Syngnathus*), and "sea-horses" (*Hippocampus*), are provided with a pouch along the lower surface of the body behind the vent, in which the eggs are carried.*

In the following cases the female cares for the eggs, but with some species the male must aid her in their first disposition.

The female *Aspredo lævis*, another South American Siluroid fish figured by Prof. Wyman (29), carries her eggs attached each one to a cup at the end of a little filament upon the lower surface of the body.

A little tree-frog (*Hylodes lineatus*), carries the young upon her back. They seemed to adhere by their mouths, aided by a viscid secretion upon the skin of the parent. (*Wyman*, 29).

Another tree-frog, the *Notodelphys ovifera*, of Venezuela, (*Weinland*, 5), presents an opening upon the back near the hinder extremity of the body, leading forward into a double pouch formed by an inversion of the skin. Into this cavity the ova are introduced, probably with the assistance of the male.

*An interesting account of the *Hippocampus* and its young, is given by Rev. S. Lockwood, (105).

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The "swamp toad "of Surinam, *Pipa Americana* (*Wyman*, 4), has an even more remarkable arrangement. After the eggs are laid, the male sticks them one by one at pretty regular intervals, upon the female's back. The skin between them grows upward so as to enclose each egg in a little cell. The mouth of each cell is closed by a glutinous secretion, and the eggs are now well protected. When hatched the little toads escape by pushing off the lid, and the cells shortly disappear, leaving the female's back as smooth as before. From a careful study of these animals, Prof. Wyman concludes that nutritive material is secreted by the skin forming the lining of each sack, and that this material is absorbed by the blood-vessels upon the surface of the yolk of the egg. A like transfer of nutritive material probably takes place with the *Aspredo*, and, Mr. Lockwood thinks, with the *Hippocampus*. Perhaps, also, some absorption occurs in the pouch of *Notodelphys*, but in the case of *Alytes* and the fishes which carry the young in the mouth, it is probable that the parent merely affords protection, and that any material absorbed is derived from the surrounding medium.

Among certain fishes the connection between the young and the parent is even more intimate than with *Pipa*. The Embiotocoids, (*Ditrema* and *Hysterocarpus*), develop ***within the ovary;*** there is a true ***ovarian gestation.*** Some account of the species is given by Agassiz, (6), but the relation of the young to the parent is

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more fully described by Blake, (108). "The ovarian sack has three coats, a peritoneal (serous), a muscular and a mucous. The mucous layer is thrown into a number of longitudinal folds; . . As the fœtal fish grows these folds extend so that each fœtus is in contact by each of two surfaces with the mucous membrane. . . . As soon as the fins are well formed, the dorsal, caudal and ventral fins become edged with a delicate membrane formed apparently entirely of capillary blood-vessels. As the fœtus grows this membrane is split up into processes or digitations which extend a considerable distance beyond the margin of the fin, sometimes as much as a quarter of an inch. . . . Their use is evidently to absorb nourishment from the fluid in the ovary, and they also serve to aerate the blood."

An ovarian gestation occurs with the genus *Anableps*, (*Wyman*, 62), and with the European species of *Zoarces;* but I am informed by fishermen that they have never found young in the American species, (*Z. anguillaris*).*

With many genera of Sharks, (*Acanthias*, *Mustelus*,

*This distinction is noted by Günther, in the Catalogue of Fishes in the British Museum. It is certainly remarkable that two species of the same genus should present a functional difference analogous to that which is popularly supposed to distinguish the whole class of Mammals from the other Vertebrates. It is stated, however, (*Owen*, 17, I, 617), that an American Boa Constrictor brought forth living young and also eggs.

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*Zygaena*, *Carcharias*, etc.), the ova lodge at various points in the oviducts, and there undergo their development. The yolks are very large, and correspondingly few in number. The contiguous surfaces of the yolk and the mucous membrane of the oviduct develop vascular processes which become intimately united so as to permit a free transfer of nutritive and respiratory material from the blood of the parent to that of the fœtus. With our common "Dog-Fish," (*Acanthias Americanus*), which is about three feet in length, the young often number five or six. They are retained until about six inches long; the yolks are then about two inches in diameter, separated from the young by a constricted portion an inch or more in length. With all the Vertebrates above mentioned, the communication between the parent and the young is effected by the vessels upon the surface of the yolk, by the *vitelline* circulation; and where an allantoic bladder* is developed, (as in Batrachians), it is not known to have any respiratory functions,†

*This organ will be fully described on page 105.

† In turtles and in Batrachians the ureters open, not into the bladder, but directly into the cloaca, or general excrementary outlet. Moreover the bladder, with these animals, is very often full of a clear fluid, resembling water rather than urine. The natural hypothesis that this may have been taken in through the cloaca for respiratory purposes during prolonged submersion, is controverted by the presence of urea and uric acid. (*Cuvier*, 12, 597 and 603).

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But among the Serpents and Lizards are some in which the eggs are hatched within the parent, and the allantois assumes at least a part of the work of interchange.

Now the Mammals also possess the allantois. The way in which it is developed and performs its functions will be fully illustrated in connection with the human embryo, (page 105). But with the lower Mammals, the Monotremes, (*Echidna* and *Ornithorhynchus*), and the Marsupials, (opossums, kangaroos, etc.), the allantois is rudimentary, as with the Batrachians, never becoming anything more than what is required as a bladder, and never forming a placenta. With these, the *implacental* Mammals, therefore, as with the fishes and Batrachians above mentioned, "the yolk or umbilical vesicle affords the principal vascular surface, by means of which an interchange takes place between the fœtus and the parent," (*Wyman*, 29, 9, note). Nor does even this connection last very long. For the young opossums or kangaroos are early born and transferred to the "marsupium," a pouch upon the front of the abdomen of the female. There each becomes attached to a nipple* and remains hanging thereto, imbibing milk and growing until ready to emerge. My friend Prof. W. S. Barnard has kindly

*In one opossum examined by me the uterus contained sixteen young although in the pouch there were but thirteen nipples.

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FIG. 13.

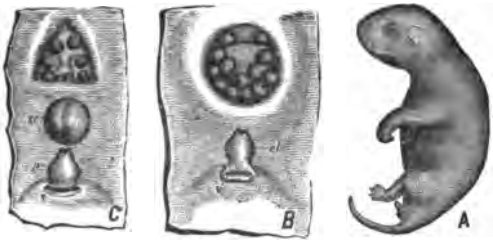


Fig. 13.—A, young female opossum (*Didelphys Virginiana*), taken from the pouch, natural size. B, view of the lower part of the abdomen of the same specimen, enlarged. *v*, vent; *cl*, clitoris. C, the same, from a male of the same litter. *p*, penis; *sc*, scrotum.

allowed me to publish drawings made by him from a male and a female young opossum taken from the pouch, (Fig. 13). At this age there is well shown the resemblance between the organs of the two sexes. The male presents a slight depression with faint indications of a few nipples; but in the adult male these have not been found, while in the female the depression becomes deeper and prolonged backward. The clitoris (*cl*), can hardly be distinguished from the penis (*p*), but the male presents a globular sack, the scrotum, (*sc*), which in these animals lies in front of the penis.

With the ordinary Mammals, in addition to its lodgment at some point of the generative passages, which constitutes *conception*, the ovum early establishes a close relation with the uterine blood-vessels by means of a special development of the allantois, the

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*placenta.* They are hence called *placental* Mammals. The placenta itself will be described farther on.

As a rule the human female produces but a single child at a birth. But with many of the lower Mammals the litter may include a dozen or more which are provided for in the long uterine cornua.

Some of the large Mammals, as the horse, cow, and elephant, bring forth but a single young at a birth. The same is stated by Owen, (17, III, *730*), to be the case with the bats (*Cheiroptera*); but his generalization seems to have been based upon two observations, and the following case shows that, with one species at least, another number would seem to prevail.

Twenty-two individuals of the little brown bat, (*Vespertilio subulatus*), were found in May hanging in an attic, by their legs, head downward, as is their wont. All of them proved to be females, and to contain each *two* young, (96).

### UTERO-GESTATION.

The period of gestation covers the most wonderful series of processes and transformations that are known to us. In the short space of nine calendar months a microscopic ovum, a speck of oil and albumen, becomes a complex organism, with all the parts of a human being, and only awaiting its entrance into the world to manifest individual life and activity. But, rapid as are these transformations, they follow a reg-

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ular and uniform course, each step being an advance upon the previous ones, and at the same time dependent upon them.

The changes which occur during gestation are chiefly those of the ovum itself, but these involve certain alterations in the size and structure of the uterus.

The simplest uterine alterations are those of the muscular coat. Its fibers enlarge in size and are said to increase in number, the blood-vessels lengthen and their caliber is increased. The extent to which the nerve fibers and nerve cells participate in these changes is not yet fully determined, but they certainly are accommodated to the prodigious enlargement of the organ and its greater capacity for action.

The clearest presentation of the alteration of the mucous coat is that of Dalton (2, *601*,) whose diagrams are here reproduced, (with his permission), and whose description is mainly followed.

In the unimpregnated condition, the mucous membrane of the body of the uterus is quite thin and delicate and presents a smooth, slightly vascular surface. It presents, throughout, minute tubular follicles about $\frac{1}{180}$ of an inch in diameter and occupying the whole thickness of the membrane. After impregnation the mucous membrane becomes tumefied and vascular; and, as it increases in thickness it projects, in rounded eminences or convolutions, into the uterine cavity, (fig. 14). In this process the tubules increase in

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length, and also become wider, so that their open mouths may be readily seen by the naked eye as minute perforations. The blood vessels of the mucous membrane also enlarge and multiply, and inosculate freely with each other, so that the vascular network

FIG. 14.

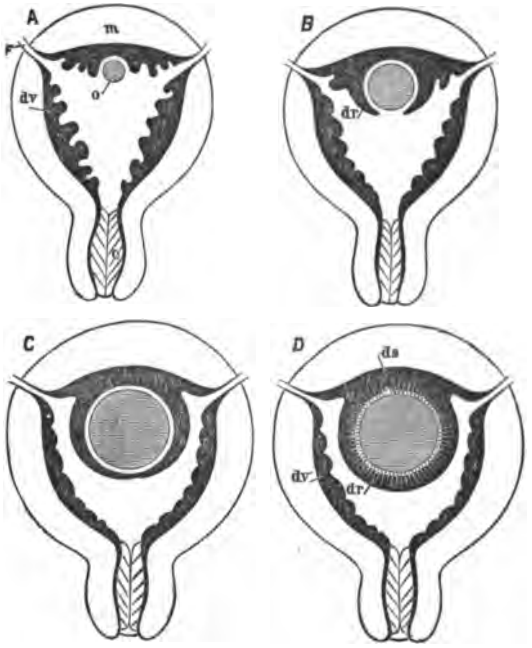


FIG. 14.—Diagrams from Dalton, showing the formation of the decidua. *F*, the Fallopian tube; *C*, cervix uteri; *m*, muscular coat of the uterus; *o*, ovum; *dv*, decidua vera; *dr*, decidua reflexa; *ds*, decidua serotina; the villi of the chorion are shown in *D*.



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encircling the tubules becomes more extensive and abundant.

As a result of this, the internal surface of the uterus soon presents a soft, thick and velvety lining which is now known as the *decidua vera*, or true deciduous membrane. The fecundated egg soon becomes lodged in one of the furrows or spaces between the projecting convolutions of the decidua; this constitutes *conception*. And now the folds begin to grow up around the egg so as to partially enclose it and shut it off from the general cavity of the uterus, (fig. 14 *B*). At last the borders of the enveloping folds meet, and the egg is now enclosed in a distinct cavity of its own (fig. 14 *C*). The new growth of the mucous membrane, reflected, as it were, upon the egg, is called *decidua reflexa* (*dr*); and from the manner of its formation, it will be seen that the orifices of uterine tubules open not only into the general uterine cavity, but also into the smaller cavity containing the egg.

The above is the account generally given of the manner in which the ovum is enveloped by the uterine mucous membrane, but Flint (90, *375*,) is inclined to adopt the view reached by Reichert after a minute examination of a uterus in which was an ovum less than one-quarter of an inch in diameter. This view is that little "islands" are formed by the mucous membrane, and that the fecundated ovum lodges upon one of these and is presently surrounded by a circular up-

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rising of the surrounding surface. The result is essentially the same according to both views.

All the parts of the decidua vera are of nearly uniform thickness and vascularity; but after the third month the increase is confined to that part to which the egg is attached, now called *decidua serotina*, and the remainder becomes comparatively thinner and less glandular (fig. 14, *D*).

But while these changes have taken place in the uterine walls, the embryo itself has been developing and has surrounded itself by certain membranes which have united with the vitelline membrane, or envelope of the egg, and so formed a compound membrane, the *chorion*. Now this chorion soon becomes covered with projecting filaments or villosities, as will be described hereafter, (fig. 16). At first these villosities are solid projections of very delicate tissue; they insinuate themselves, as they grow, into the uterine tubules, and between the folds of the mucous membrane. When the decidua reflexa is complete, the chorion has become uniformly shaggy, as seen in fig. 14, *D*. The nutritious fluids, exuded from the soft and glandular texture of the decidua are now readily imbibed by the villosities, and a more rapid supply of nourishment is now provided corresponding in abundance with the increasing size of the egg. When, as will be hereafter described, the chorion becomes vascular through the formation of blood-vessels in the

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allantois, each villosity contains a vascular loop, through which the fœtal blood circulates, increasing the rapidity with which absorption and exhalation take place. In the pig and the horse, this condition of the chorion persists during gestation, and constitutes what is called a *diffused* or *general placenta*. In the cat and the dog, the villi disappear over a great part of the chorion, but develop still more in a ring or belt around its middle, forming what is called a *zonary* placenta. With cows and sheep the villi which persist form little groups or tufts, the *cotyledons*. In bats, and monkeys, and human beings a single large patch of villi remains and forms the *discoid* placenta.*

At this point all the structures grow still more, and the connection between the ovum and the uterus becomes very intimate; while all the other parts of the decidua, both vera and reflexa become thin and membraneous.

In the placenta we have the following arrangement. Little vascular tufts or villosities project every where from that part of the chorion and are received into follicles and pits of the decidua serotina, between

* Attempts have been made to classify mammals according to their placentation; but there are manifest incongruities in such arrangements, and Huxley (63, *273*,) admits that his proposed subdivision must be regarded as provisional. At best, placentation is a feature manifested in only one sex, and at certain limited periods.

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which is a network of minute vessels. By degrees these vessels enlarge and encroach upon the spaces between them to such an extent as to fuse with each other, and finally they become dilated into wide sinuses which communicate freely with the enlarged vessels in the muscular walls of the uterus. Furthermore, the walls of the fœtal blood vessels unite with the walls of the uterine capillaries with which they are in contact, so as practically to have but a single wall, which becomes very thin. The result of this is

FIG. 15.

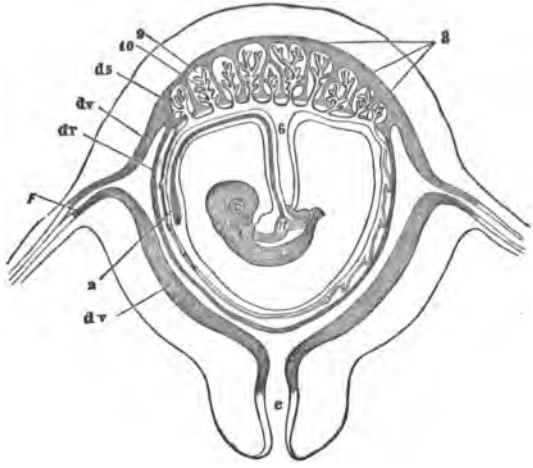


FIG. 15.—Diagrammatic section of the pregnant uterus, from Huxley. *F*, Fallopian tube; *c*, cervix uteri; *dv*, decidua vera; 8 and *ds*, decidua serotina; *dr*, decidua reflexa; 1, the embryo; 2, the umbilical vesicle reduced and pushed aside; 6, allantois; 9, uterine sinus; 10 placental tuft; 11, intestine.

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FIG. 16.

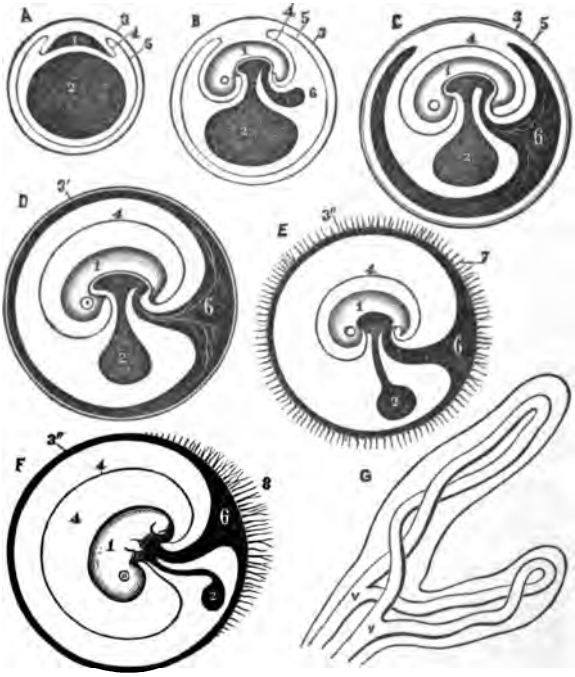


Fig. 16, *A* to *F*. Diagram (from Dalton) showing the formation of the amnion, the allantois and placenta. *G*, a vascular villosity of the chorion, enlarged; *vv*, looped vessels. The numbering is uniform throughout. 1, the embryo gradually formed upon the surface of the yolk; 2, the vitellus, or yolk, or umbilical vesicle, which is gradually absorbed into the embryo, and at last hangs by a slender pedicle; 3, the vitelline membrane, or original membrane outside of the egg; 4, the inner layer of the amnion; 5, the outer amniotic layer; 6, the allantois; 7, the villi; 8, the specialized villi, which are to form the placenta, and of which one, enlarged, is shown at *G*; 3′, the double membrane formed by the union of the outer amniotic layer with the vitelline membrane; 3″, the *chorion*, formed by the union of the allantois with the preceding. For farther explanation of the figures, see the text and Fig. 16 Ba.

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that the blood-vessels are left floating in the uterine sinuses bathed with the blood which they contain, and capable of effecting the exchange of material between the maternal blood in the sinuses and the fœtal blood in the vascular tufts. In this way the embryo receives oxygen and the other elements required for its growth, while it gives off carbonic acid gas and the other impurities which arise in the processes of nutrition. The arrangement is shown in Fig. 15, and is comparable to that by which the gills of a fish carry on respiration in the water.

We are now better prepared to understand the purpose of the formations already alluded to as concerned in the vascular communication between the mother and the child. They are the *amnion* and the *allantois*

The amnion is formed in the following manner. Soon after the body of the embryo has begun to be formed by the thickening of the outer layer of the yolk, (called the external blastodermic membrane) a double fold of this layer rises up on all sides about the edges of the newly formed embryo, so that the body appears as if sunk in a kind of hollow, as seen in Fig. 16, A. The figure shows the surrounding wall only in profile, but it must be understood that it rises upon all sides. The folds so formed are called the *amniotic folds;* by extending themselves from all directions toward the centre, they at last approach each other over the back of the embryo. The gap

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which remains for a time is the *amniotic umbilicus*, (fig. 16 *B*). This gap afterwards closes up by the approximation and union of the margin, presenting the appearance shown in figure 16 *Ba*. Here we see the embryo (1) completely surrounded by the amniotic folds which have met over its back at the point 4′. By a fusion and absorption at this point the *inner layer* (4) becomes wholly separated from the *outer layer* (5) and the intervening space becomes continuous, the *outer amniotic cavity* (4‴). By the expansion of the

FIG. 16 *Ba*.

FIG. 16 *Ba*. Represents the stage intermediate between fig. 16 *B* and *C*. 1, the embryo; 2, the vitellus; 3, vitelline membrane; 4, inner amniotic layer; 5, outer amniotic layer; 4′, point of union of the amniotic folds; 4″, inner amniotic cavity; 4‴, outer amniotic cavity (between the two layers); 6, allantois. This figure is a simple modification of Dalton's.

outer layer and its subsequent union with the vitelline membrane to form a single membrane (Fig. 16 *D*), this outer cavity is enlarged for a purpose which will appear presently. The smaller space, between the inner amniotic layer (4) and the embryo, is the *inner amniotic cavity* (4″) and contains a clear liquid, the *liquor amnii*, in which the embryo swims. At a later period this cavity is enlarged by the expansion of the inner amniotic layer and the liquid is known as "the waters," escaping at the time of birth.

During these changes the alimentary canal has been formed and the yolk has been partially separated from the embryo, hanging therefrom as the *umbilical vesicle*

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(2) by a hollow pedicle, the *vitelline duct*, through which its contents are gradually absorbed.

From the alimentary canal just behind the attachment of the umbilical vesicle there has been protruded a little pouch or diverticulum (fig. 16, 6). This is the *allantois*. As it increases in size it projects as a flattened sack into the outer amniotic cavity, extends itself upon all sides so as finally to meet and fuse as did the amniotic folds. Vessels appear upon it derived from the intestinal circulation, and in figure 16 *D* it is seen as a flattened vascular sack completely enveloping the embryo outside of the inner amniotic layer. Its outer and inner layers then unite and fuse with the membrane already described (3′) as resulting from the union of the vitelline membrane and the outer amniotic layer, and all together then constitute a single membrane, the *chorion* (fig. 16 *E*, 3″).

From the whole surface of the chorion are now developed the villi already described, (*E* 7) which, at first solid, afterwards contain loops of the blood vessels from the allantois, and present the appearance seen in figure 16, *G*. Later, at the end of the third month, the villi exist only at one spot upon the chorion (*F* 8), and this forms the placenta, already described.

We now come to the changes which occur in the ovum itself.

*Segmentation of the Ovum.* The first result* of the

* According to Flint (90, *355*), it is probable that in Mammalia there is

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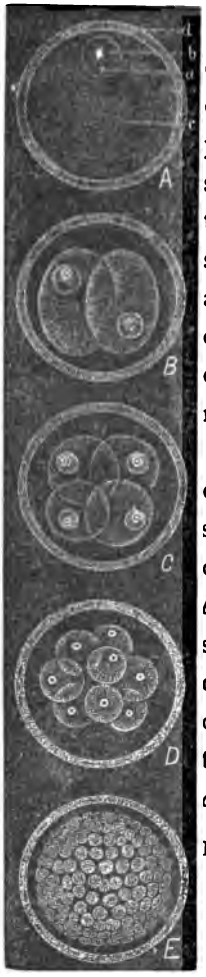
FIG. 17.




contact of the zoösperms with the ovum is the spontaneous subdivision of the whole or (in some animals) a part of the yolk into smaller and smaller balls or segments; first into two, next into four, eight, sixteen and so on, (fig. 17). This results in the rearrangement of the yolk as a finely divided granular mass which then proceeds to develop upon its surface the new being, the *embryo*.

With man and other mammals, excepting perhaps the monotremes, the segmentation involves the entire ovum, which is hence called *holoblastic*. But with the birds, reptiles, selachians (sharks and skates) and ordinary fishes, the segmentation affects only one side (always the upper) of the yolk, which is thence called *meroblastic;* strangely enough, however,

FIG. 17.—The human ovum and its stages of segmentation, enlarged 100 diameters, from Haeckel. *c*, contents of the ovum; *d*, its envelope, or vitelline membrane or *zona pellucida; b*, the nucleus; *a*, the nucleolus.

formed a "polar globule" similar to that which Robin has demonstrated in the *Limnæus stagnalis*, (a slug). But the existence and significance

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in the lowest vertebrates (the lampreys and *Amphioxus*) we again find a holoblastic ovum, as in the *Ascidians*, with which, according to Haeckel and others, the *Amphioxus* is related by descent.

In diagrammatic figures and general descriptions it is correct enough to describe the lines of segmentation as crossing each other at right angles so as to produce smaller and smaller portions of equal size. But in point of fact, such *absolute regularity* no more prevails in the segmenting ovum, than it does in the cell of the honey-bee, as shown by Wyman (86), or in the nets of the garden spiders, *Epeiridæ*, as stated in 87. "It is impossible to say how long the process of segmentation continues in the human ovum. It is stated that in rabbits it is completed in a few days, and in dogs that it occupies more than eight days." (*Flint*, 90, *36*).

*The Primitive Trace.* The cells formed by the segmentation of the vitellus form a continuous tissue, at the surface of the yolk, called the *blastodermic membrane*. This soon presents upon its surface a straight line, the *primitive trace*, or *groove*, or *furrow*. This has been generally described as gradually deepening so as to form at last a decided furrow, the sides of which then grow up and at last convert it into a

of this and of the vitelline nucleus in the human ovum are at present undetermined, and need not be dwelt upon here.

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closed canal corresponding with the spinal canal of the embryo.*

FIG. 18.

FIG. 16.—The primitive furrow just forming upon the surface of the yolk. (From Dalton).

Dareste has observed upon the yolks of hen's eggs, two primitive traces, either wholly separate and lying nearly parallel (| |) or joining at one end (Y or ⅄). This naturally suggests that the compound monsters (with two heads and supernumerary front limbs, or two pelves and supernumerary hinder limbs, or more or less completely double, like the Siamese twins), which are by no means infrequent among human beings and domesticated animals,† are not, as formerly

*Later investigations (Balfour, Quarterly Journal of Microscopical Science, 1873, p. *278*), indicate that in the chick, at any rate, this primitive trace is a temporary appearance, and that it is superseded by a new furrow, which begins in front of it. In either case the primitive trace indicates the location and direction of the longitudinal axis of the embryo, the spinal cord, and the primitive spinal column or *notochord*.

† There have lately come into the author's hands several such mal-

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FIG. 19.

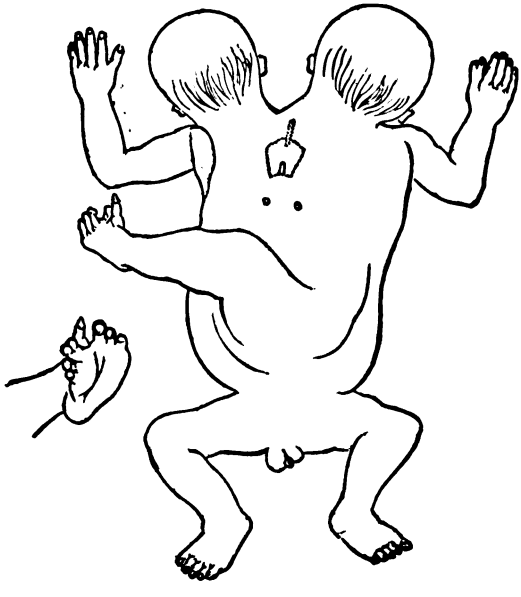

FIG. 19.—Dicephalous Monster, from behind; one-sixth of natural length. It has two legs, and a third median limb made up by the union of the left leg of the right child and the right leg of the left child. The third or median arm is a papilla, under which were a median scapula and clavicle.

supposed, the result of the partial fusion of two distinct ova, (which would otherwise have produced twins), but of the formation upon a single ovum of two primitive stripes. Upon the former hypothesis it

formed children, calves, pigs and fowls awaiting examination. One of these is represented above (Fig. 19).

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would be difficult to account for the *uniform identity of sex* in the two individuals, and for the *union of corresponding or homologous parts:* while both these conditions would be anticipated from the formation of two furrows upon the same ovum.

Prof. Wyman (83 and 84) has clearly pointed out the analogy which exists between the way in which the embryo is formed about the longitudinal axis and the manner in which matter capable of assuming a polar condition distributes itself about a magnet, and upon this has based a strong argument in favor of the fore-and-hind symmetry of the ideal vertebrate body which was foreshadowed by Oken, (31, par. 3114).

In order to understand the formation of the other parts of the embryo, it is necessary to state that the blastodermic membrane referred to on page 107 separates into two layers, the *outer* and the *inner* blastodermic membranes, also called *epiblast* and *hypoblast.** These seem to be at least analogous to the ectoderm and entoderm, respectively, of the Hydroids; (see pages 69 to 80, and Fig. 12). Between these two, in a manner not as yet fully understood, is formed a third layer, called the *middle germ layer*, or *mesoblast*. This likewise subdivides into two. The space between them becomes the great serous (pleuro-peri-

* These are also called by some *ectoblast* and *entoblast*. These terms, however, have been employed by Agassiz (71, I, *464*) to designate the cell-membrane and the nucleolus; mesoblast being likewise used for nucleus.

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FIG. 20.

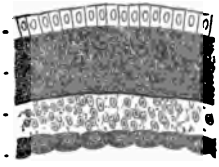


FIG. 20.—(From Haeckel, 104, Fig. 29). "Diagrammatic section of the outer part of the germinative disk or blastoderm of one of the higher Vertebrates, where the four secondary blastodermic membranes are in contact." The explanatory words at the sides of the figure are mainly paraphrased from Haeckel's Tables, (104, *163*, *164*).

toneal cavity of the body.* The inner subdivision seems to unite with the hypoblast to form the walls of the alimentary canal and, perhaps, the ovaries. The outer subdivision apparently unites with the epiblast to form the skin, the muscular masses, the skeleton and the nervous system, and, perhaps, the testes. The foregoing diagram (Fig. 20) and Table may be useful for illustration. (See also Fig. 12, I). But (as may be seen in Stricker, 64, *1078*) there is still considerable doubt as to the parts played by the different layers in the formation of the embryo. Particularly is this the case with the sexual organs.

At any rate, there is formed in the floor of the canal above mentioned a rounded cord of compact cel-

* For the lengthy terms *pleuro-peritoneal* or *thoracico-abdominal cavity*, Haeckel (104, *181*), proposes the single word *coelum*. In mammals the diaphragm divides the thorax from the abdomen.

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lular tissue, which is called the *notochord.* In *Amphioxus*, the lowest vertebrate, this is a tube with semi-solid contents, thicker at the centre and tapering at both ends. But with most other vertebrates it is partly or wholly obliterated by the formation about it of cartilaginous or bony pieces, the *vertebræ* (fig. 17). According to Wyman, (83, *250*), the deposition of these segments commences at or near the middle of the body of the future embryo, and proceeds forward and backward in a symmetrical manner.*

FIG. 21.

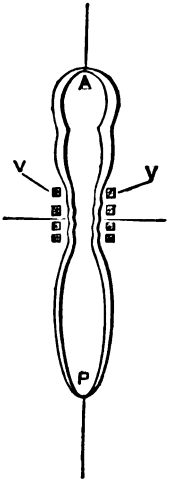


Fig. 21. Diagram to show the manner of formation of the primitive vertebræ upon the sides of the furrow, beginning near the middle and advancing forward and backward in a symmetrical manner. (From Wyman).

Just above the notochord is formed a strip of more delicate structure, the *spinal cord*, the anterior end of which afterward be-

* Other authors are of the opinion that the first vertebral segments appear at a point corresponding with the junction of the head with the neck. In either case the great anatomical and physiological distinctions which in the adult characterize the head and tail do not exist in the earliest stages; and there is at least one vertebrate, the *Amphioxus*, whose two ends are more nearly alike than the right and left sides of certain invertebrates or even our own abdominal viscera. The significance of this antero-posterior resemblance, or "meketropy," has been discussed by Wyman (83 and 84), by Coues (85), and by myself (32).

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comes the brain. The cartilaginous and afterward bony segments or vertebræ are deposited beneath and around the notochord.

By a further development and differentiation of tissue the substance immediately surrounding the primitive furrow gradually becomes an elongated

FIG. 22.

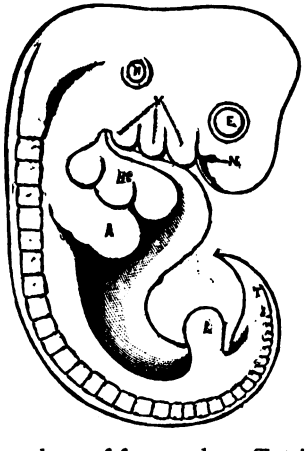


FIG. 22.—A human embryo of four weeks. *T*, tail; *L*, right leg; *A*, right arm; *Ht*, heart, in process of formation; *H*, ear; *E*, eye; *V*, three of the visceral arches, separated by the visceral clefts; *N*, nostrils. The yolk-sack and allantois are not shown. (See Fig. 23). From Haeckel, (78, taf. III).

body, of which one end becomes head and the other tail; for man, like all other Mammals, is at first provided with a tapering caudal appendage (Fig. 22, *T*), which later is concealed by the enlargement of the legs, and is represented in the skeleton by the coccyx.



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The arms and legs are at first little flat pads, projecting from the sides. Their tips subdivide into fingers and toes. The further protrusion of the limb and its flexion at several points give rise to the segments, arm and thigh, fore-arm and leg, hand and foot, with intervening joints, elbow and knee, wrist and ankle.

It is interesting to note among the lower mammals, permanent conditions of the limbs corresponding to the stages through which they pass in man. Thus, the webbed feet of the seal and ornithorhynchus typify the period when the hands and feet of the human embryo are as yet only partly subdivided into fingers and toes. Indeed, it is not uncommon for the "web" to persist to some extent between the toes of adults; and occasionally children are born with two or more fingers or toes united to their tips.

With the seal and the walrus the limbs are protruded but little beyond the wrist and ankle. With the otter they project a little farther. With the ordinary quadrupeds the knee and elbow are visible. The cats, the lemurs, and the monkeys form a series in which the limbs are successively freed from the trunk and in the highest apes they are capable of nearly the same movements as the human arm and leg which, in their development, passed through all these stages.

The manner of formation of the internal organs is even more extraordinary. The heart, for instance, is

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at first a straight tube, open at each end, which coils and twists upon itself, and subdivides both lengthwise and crosswise so as to form the four-chambered organ which propels the blood in the adult.

The alimentary canal is at first a straight tube, without curvature or enlargement, which is, by the way, its permanent condition in the lowest vertebrates, the *Amphioxus* and the lamprey eels. The stomach and cæcum are dilatations, and the convolutions are gradually formed by the elongation of the tube within a confined space. This usually occurs so as to throw the stomach on the left side of the abdomen and the cæcum on the right; but sometimes this arrangement is reversed, and the stomach is found upon the right and the cæcum upon the left. In such cases there is a complete transposition of viscera, the heart being more upon the right side, and the liver upon the left. Some of the individuals in which this condition of things has existed have been left-handed, and it is desirable for all left-handed people to have the position of their viscera ascertained either before or after death.

In connection with these abnormal positions of the viscera, it is worth while to call attention to the large number of individuals who have an additional finger or toe on one or more of their limbs. In almost every neighborhood such cases may be found. In 1868 I tabulated the cases at that time known to me

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from books and other sources, (67). Two years later the numbers had increased so as to present the following statistics: The number of individual sexdigitists was 242; of which 152 were males, and 59 females, the sex of the remaining cases not being recorded. Of the 467 affected limbs, 312 were hands, and 155 feet. The number of right limbs was 204, the number of left 190. The following table shows the relative frequency of the several extra digits:

| | |
|---|---|
| Right little fingers, | 85 |
| Left " " | 80 |
| Right little toes, | 47 |
| Left " " | 43 |
| Right thumbs, | 33 |
| Left " | 23 |
| Left great toes, | 10 |
| Right " " | 9 |
| | 330 |

In the paper above cited there are offered some considerations as to the cause and significance of these facts. But at present I wish only to call attention to the frequency of the cases, and to request that those who know of such will communicate with me. The numbers above given have been largely increased during the four years since the last tabulation, but I do not wish to publish again until the total number of cases reaches 1000. To those who wish to record

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cases I will send blank forms, with spaces for the items desired. [The monster shown in Fig. 19 presents an extra thumb upon the right hand].

FIG. 23.

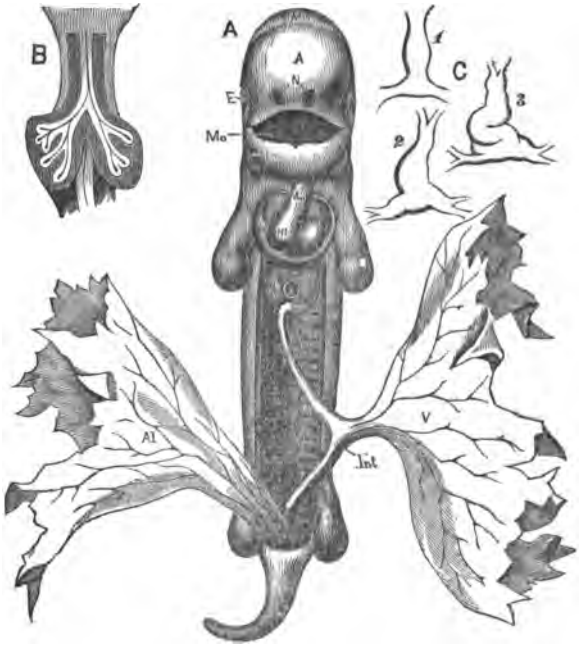


FIG. 23. A, embryo of a dog of twenty-five days; from Bischoff, (97, Fig. 42, C). *A*, anterior cerebral vesicle; *M*, middle cerebral vesicle; *E*, eye; *N*, nostrils; *Mo*, mouth; *Ht*, heart; *Ao*, aorta; *L*, liver; *Int*, intestine; *V*, yolk sack, turned aside; *Al*, part of the allantois, turned aside. The arms, legs and tail need no lettering. B, lungs of the same embryo, showing their simple condition as a double sack projected from the alimentary canal. C, diagrams representing the development of the heart of a chick, in its progress from a simple straight tube to the four-chambered organ of the adult; from Ecker, after Quain.

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So closely do the early stages of the higher mammals resemble one another that the preceding figure from Bischoff, representing an embryo dog at about twenty-five days may serve to illustrate the condition of the human embryo at a corresponding stage. The parts shown are sufficiently indicated by the explanation of the figure. The intestine is a nearly straight tube, from which are given off two diverticula. The more anterior (*V*) is the yolk-sack upon which the embryo was first formed, but which now appears as a mere appendage to it. The hinder diverticulum is the allantois (*A*). Upon both of these are seen blood vessels. At B is shown the early condition of the lungs. At C are represented three successive stages in the development of the heart.

The face is formed in a very complex way, and from its earliest condition no one would imagine that the later stages could be evolved. Some of the minor details of the process are somewhat obscure, but the general features of it are understood to be as follows, (see Fig. 24). From the lower border of the prominence called the anterior cerebral vesicle, *A*, there is projected downward a rather broad bud, the *frontal process* (*F*). A little notch appears near the outer angle upon each side, so as to leave a median portion and two lateral portions. In the former is later developed the intermaxillary bone, which forms the middle portion of the upper jaw and bears the incisor

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## FIG. 24.

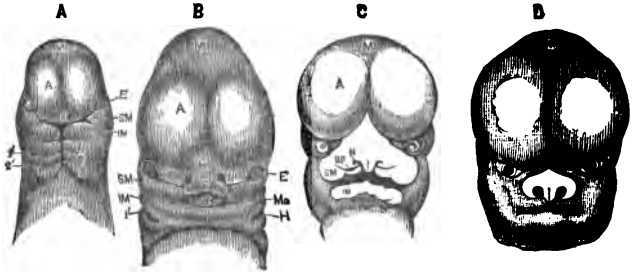


FIG. 24.—Development of the face. A and B from Ecker, after Quain; C and D from Dalton; slightly altered and uniformly lettered. A, head and neck of a human embryo of about three weeks, seen from in front; B, of about five weeks; C, of about six weeks; D, of about two months. *A*, prominences representing the anterior vesicle of the brain, which becomes the *optic thalami*, the *cerebral hemispheres* and the *olfactory lobes*; *M*, the middle cerebral vesicle, which becomes the *optic lobes*; (the posterior cerebral vesicle is not seen in these figures; it forms the *cerebellum* and *medulla oblongata*). *F*, the frontal process, the middle part of which becomes the intermaxillary bone, and supports the incisor teeth. *NP*, the nasal processes, which are the outer portions of the frontal process, protruded and incurved so as to enclose the nostrils, *N*. *E*, the eye. *SM*, the superior maxillary processes, which unite with the sides of the intermaxillary process and so form the upper jaw; *IM*, the inferior maxillary processes, which meet upon the middle line and form the lower jaw. *1*, *2*, *3*, the first, second and third visceral arches; *1'*, *2'*, the corresponding clefts between the arches. *H*, the unclosed portion of the first cleft, forming the external auditory meatus; *Mo*, the mouth, the space between the superior and inferior maxillary processes; *T*, the tongue. Authors do not wholly agree as to the enumeration of the visceral arches, but the above corresponds with the account given by Dalton and Flint. See also Haeckel, 104, *542*, *545*, Taf. iv, v.

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teeth. The latter or nasal processes (*NP*) elongate and curve inward so as to enclose little holes, which are the nostrils, *N*. Still farther out there is formed, on both sides, a bud, the superior maxillary process (*SM*), which grows toward the middle line and eventually unites with the median portion of the frontal process, so as to form the upper jaw. When this union fails to occur, "hare-lip" is the result; this deformity may exist upon one or the other side, or upon both sides, constituting "double hare-lip." The eyes (*E*) are formed upon the sides of the head, where they remain in many of the lower animals, as most fishes, reptiles and birds, and even some mammals, as the rabbit, etc. But in man and monkeys they gradually move toward the front, and at last occupy the same lateral plane, so as to both look forward.

Meantime there have been developed four (or perhaps five) other pairs of processes which grow forward and inward from the side so as to form by their union so many *arches*, and to leave between them clefts or fissures. The uppermost of these arches is called the inferior maxillary (*IM*), and forms the lower jaw. The others are called *visceral* arches, and also *branchial* arches, because they seem to represent the gill arches of fishes. They never bear any gills, however, in the true reptiles birds and mammals. By some the inferior maxillary processes are regarded as constituting the first branchial arch, and some also enumerate four

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in addition. The clefts close up, for the most part, but the hinder part of the first cleft remains open upon each side, and becomes the external auditory meatus or outer ear passage. For further accounts of the formation of these and other organs, the reader is referred to Dalton (2), Quain (76) and Flint (90). The development of the brain is clearly described by Huxley, (63).

The following summary by Scanzoni (as quoted by Flint, 90, *448*), indicates the general progress of development.

"At the third week the embryon is from two to three lines" [less than one-fourth of an inch] "in length. This is about the earliest period at which measurements have been taken in the normal state.

"At the seventh week the embryon measures about nine lines. Points of ossification appear in the clavicle and the lower jaw; the Wolffian bodies are large; the pedicle of the umbilical vesicle is very much reduced in size; the internal organs of generation have just appeared; the liver is of large size; the lungs present several lobules.

"At the eighth week the embryon is from ten to fifteen lines in length. The lungs begin to receive a small quantity of blood from the pulmonary arteries; the external organs of generation have appeared, but it is difficult to determine the sex; the abdominal walls have closed over in front.

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"At the third month, the embryon is from two to two and a half inches long, and weighs about one ounce. The amniotic fluid is then more abundant, in proportion to the size of the embryon, than at any other period. The umbilical cord begins to be twisted; the various glandular organs of the abdomen appear; the pupillary membrane is formed; the limitation of the placenta has become distinct. At this time, the upper part of the embryon is much larger than the lower portion.

"At the end of the fourth month, the embryon becomes the fœtus. It is then from four to five inches long, and weighs about five ounces. The muscles begin to manifest contractility; the eyes, mouth, and nose are closed; the gall-bladder is just developed; the fontanelles and sutures are wide.

"At the fifth month, the fœtus is from nine to twelve inches long, and weighs from five to nine ounces. The hairs begin to appear on the head; the liver begins to secrete bile, and the meconium appears in the intestinal canal; the amnion is in contact with the chorion.

"At the sixth month, the fœtus is from eleven to fourteen inches long, and weighs from one and a half to two pounds. If born at this time, life may continue for a few moments; the bones of the head are ossified, but the fontanelles and sutures are still wide; the prepuce has appeared; the testicles have not descended.

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"At the seventh month, the fœtus is from fourteen to fifteen inches long, and weighs from two to three pounds. The hairs are longer and darker; the pupillary membrane disappears, undergoing atrophy from the centre to the periphery; the relative quantity of the amniotic fluid is diminished, and the fœtus is not so free in the cavity of the uterus; the fœtus is now viable.

"At the eighth month, the fœtus is from fifteen to sixteen inches long, and weighs from three to four pounds. The eyelids are open and the cornea is transparent; the pupillary membrane has disappeared; the left testicle has descended; the umbilicus is at about the middle of the body, the relative size of the lower extremities having increased.

"At the ninth month, the fœtus is about seventeen inches long, and weighs from five to six pounds. Both testicles have usually descended, but the tunica vaginalis still communicates with the peritoneal cavity.

"At birth, the infant weighs a little more than seven pounds, the usual range being from four to ten pounds, though these limits are sometimes exceeded."

## PARTURITION—(*BIRTH*).

The duration of human gestation is roughly stated as nine calendar months, or about forty weeks. Still

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more accurately, according to Duncan, it may be said that from impregnation to parturition is, on the average, 275 days, and from the close of menstruation to parturition is, on the average, 278 days; but both these periods vary within certain limits.

At the appointed time, from internal causes respecting which we are ignorant, or at an earlier period when the woman has experienced any severe bodily or mental impression, the muscular walls of the uterus contract and expel its contents.

Animals gnaw asunder the cord near the body of the young. Most authorities agree that, in human birth, it should not be severed until pulsation has ceased, this being a sign that the new circulation and respiration of the child have been established.

*Changes in the Circulation and Respiration at Birth.* Few realize the character and extent of the change which occurs at birth, in regard to these vital processes. It must be remembered that during fœtal life the lungs are inactive; they are developing and growing like other organs, but receive only so much blood as is required therefor. At birth, however, they expand and receive all the blood from the right side of the heart. This involves the opening of some passages and the closing of others, and the transformations will be now briefly described.

As seen in the accompanying diagram, (fig. 25), the blood of the fœtus is sent through the *hypogastric*, or

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FIG. 25.

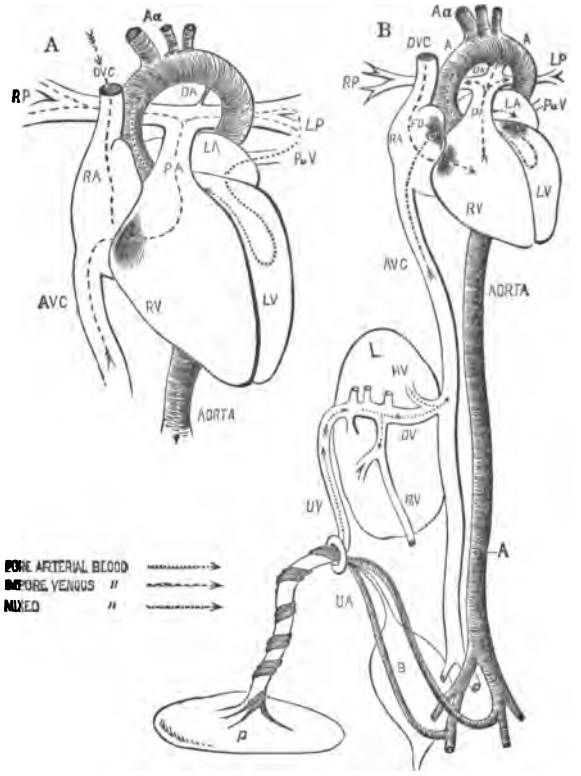


FIG. 25.—*A*, diagram of the adult heart; *B*, diagram of the fœtal circulation, slightly altered from Flint and Gray. The lettering is the same in both. *RA*, right auricle; *RV*, right ventricle; *LA*, left auricle; *LV*, left ventricle; *AVC*, ascending vena cava; *DVC*, descending vena cava; *PA*, pulmonary artery; *RP*, and *LP*, right and left branches of the pulmonary artery; *DA*, ductus arteriosus; *A*, aorta; *Aa*, branches of the aorta supplying the head and arms; *P*, placenta; *UA*, umbilical arteries; *UV*, umbilical veins; *L*, liver; *DV*, ductus venosus; *HV*, hepatic vein; *FO*, foramen ovale; *B*, bladder; PoV, portal vein.

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*umbilical* arteries (*UA*) to the placenta (*P*). Here it gives up its carbonic acid, and receives from the maternal blood a supply of oxygen and of nutritive material, which is returned through the umbilical vein (*UV*) to the liver (*L*). Part of this blood passes directly by the *ductus venosus* (*DV*) into the *ascending vena cava* (*AVC*), and part circulates through the liver before reaching that vessel by the *hepatic vein* (*HV*). In the vena cava it is mixed with a small amount of impure blood, which has come from the lower part of the fœtus, and carried upward into the right auricle of the heart (*RA*). It passes directly across the auricle, being guided by a projecting fold, the Eustachian valve, (which is larger in the fœtus than in the adult), and enters the left auricle (*LA*) through an aperture, the *foramen ovale* (*FO*), which in the fœtus connects the two auricles, but which closes after birth. The left auricle sends it into the *left ventricle* (*LV*), and this propels it into the *aorta* (*A*). From the arch of the aorta are given off the arteries which supply the head and the arms (*Aa*). The blood which is not taken by these branches passes onward in the aorta, but here it is mingled with a stream which has come through the *ductus arteriosus* (*DA*), and the source of which must now be described.

The blood which has circulated through the head and arms, and is of course charged with carbonic acid

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and other impurities, is returned through the *descending vena cava* (*DVC*) to the right auricle (*RA*). Here it probably mingles a little with the stream of purer blood which is crossing its course from the ascending vena cava, but the larger part of its current passes directly across the auricle into the right ventricle, which expels it through the *pulmonary artery* (*PA*). A little of this blood is taken by the branches (*RP*) and (*LP*) to the right and left lungs, but most of it continues on through a short trunk, the *ductus arteriosus* (*DA*) and so enters the aorta, to mingle with the purer blood which has come from the left ventricle. The combined streams of mixed blood are carried by the aorta and its branches to the trunk, the abdominal viscera and the legs; also, as already described, through the hypogastric arteries to the placenta.

The following summary of the fœtal circulation is given by Gray (3, *639*):

"1. The placenta serves the double purpose of a respiratory and nutritive organ, receiving the venous blood from the fœtus and returning it again reoxygenated and charged with additional nutritive material.

"2. Nearly the whole of the blood of the umbilical vein traverses the liver before entering the vena cava; hence the enormous size of this organ, especially at an early period of fœtal life.

"3. The right auricle is the point of meeting of a double current, the blood in the (inferior) ascending

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cava being guided by the Eustachian valve into the left auricle, whilst that in the superior (descending) cava descends into the right ventricle. At an early period of fœtal life it is highly probable that the two streams are quite distinct; for the inferior cava opens almost directly into the left auricle, and the Eustachian valve would exclude the current along the tube from entering the right ventricle. At a later period, as the separation between the two auricles becomes more distinct, it seems probable that some slight mixture of the two streams must take place.

"4. The blood carried from the placenta to the fœtus by the umbilical vein, mixed with the blood from the inferior cava, passes almost directly to the arch of the aorta, and is distributed by the branches of this vessel to the head and upper extremities; hence the large size and perfect development of these parts at birth.

"5. The blood contained in the descending aorta, chiefly derived from that which has already circulated through the head and limbs, together with a small quantity from the left ventricle, is distributed to the lower extremities, hence the small size and imperfect development of these parts at birth.

"*Changes in the Vascular System at Birth.* At birth, when respiration is established, an increased amount of blood from the pulmonary artery passes through the lungs, which now perform their office as

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respiratory organs, and at the same time the placental circulation is cut off. The foramen ovale becomes gradually closed in by about the tenth day after birth; a valvular fold rises up on the left side of its margin, and ultimately above its upper part; this valve becomes adherent to the margins of the foramen for the greater part of its circumference, but, above, a valvular opening is left between the two auricles, which sometimes remains persistent.

"The *ductus arteriosus* begins to contract soon after respiration is established, becomes completely closed from the fourth to the tenth day, and ultimately degenerates into an impervious cord, which serves to connect the left pulmonary artery to the concavity of the arch of the aorta.

"Of the *umbilical* or *hypogastric arteries*, their commencement forms the trunk of the corresponding internal iliac; the portion continued on to the bladder remains pervious, as the superior vesical artery; and the part between the fundus of the bladder and the umbilicus becomes obliterated between the second and fifth days after birth, and forms the anterior true ligament of the viscus.

"The *umbilical vein* and *ductus venosus* become completely obliterated between the second and fifth days after birth, and ultimately dwindle to fibrous cords; the former becoming the round ligament of the liver, the latter the fibrous cord which, in the



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adult, may be traced along the fissure of the ductus venosus to the inferior cava."

## HYGIENE OF REPRODUCTION.

Having already (page 62) treated of the care required for the proper maintenance of the menstrual function, and, for various reasons, here omitting reference to excesses and other errors of the married, there remain to be presented the two great evils to which youth is liable, *self-pollution* and *illicit intercourse.*

*Masturbation. Self-pollution. The Solitary Vice.* "This is resorted to from various motives. With many there is no opportunity for the natural gratification of their appetites: some are deterred from such gratification by the fear of discovery, regard for character, or a dread of disease; others there are whose consciences revolt at the idea of licentious intercourse, who yet addict themselves to this practice with the idea that there is in it less of criminality. It is to be apprehended, however, that its commencement can usually be traced to a period of life when no such causes can have been in operation. It is begun from imitation, and taught by example, long before the thoughts are likely to have been exercised with regard either to its dangers or its criminality. The prevalence of this vice among boys seems to be connected with the great amount of illicit indulgence which exists among young men. It prepares the way, it excites the

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appetite, it debauches the imagination. There is little doubt that it is often, if not commonly, begun at a period of life when the natural appetite does not, and should not, exist. It is solicited—prematurely developed; it is almost created. On every account, then, this practice in the young demands especial notice. It is the great corrupter of the morals of our youth, as well as a frequent destroyer of their health and constitution. Could it be arrested, the task of preventing the more open form of licentiousness would be comparatively easy; for it creates and establishes, at a very early age, a strong physical tendency, an animal want of the most imperious nature, which, like the longing of the intemperate man, it is almost beyond human power to overcome. The brute impulse becomes a habit of nearly irresistible force before the reason is instructed as to its injurious influence on the health, or the conscience awakened as to its true character as a sin.

"The deleterious, the sometimes appalling consequences of this vice, upon the health, the constitution, the mind itself, are some of the common matters of medical observation. The victims of it should know what these consequences are; for, to be acquainted with the tremendous evils it entails, may assist them in the work of resistance." (*Ware, 45*).

Professor Storer refers to this vice as "the terrible and destructive custom of self-indulgence, that

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solitary sin that has hurried so many men to the madhouse and to the grave. To this I need not allude, for hardly the person exists who does not know, from experience or from observation, its blighting effects. With the prudery which prevents the parent from cautioning his son, or the physician his patient, from this violation of every natural instinct and every physiological law, I have no patience. Enfeebling to the body, enfeebling to the mind, the incarnation of selfishness, it effaces from its victim his fondness for the other sex, unfits him for true love, and likens him in very fact to that embodied concentration of all man's frailties, devoid of all the apparent virtues of animals still lower in the scale, the ape." (*Storer*, 9, *49*).

"Among the effects of this habit in ordinary cases, we notice an impaired nutrition of the body; a diminution of the rotundity which belongs to childhood and youth; a general lassitude and languor, with weakness of the limbs and back; indisposition and incapacity for study or labor; dullness of apprehension; a deficient power of attention; dizziness, headaches, pains in the sides, back and limbs; affections of the eyes. In cases of extreme indulgence, these symptoms become more strongly marked, and are followed by others. The emaciation becomes excessive; the bodily powers become more completely prostrated; the memory and the whole mind partake "in the ruin; and idiocy or insanity in their most intract-

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able forms, close the train of evils. It not unfrequently happens that from the consequences of this vice, when carried to an extreme, not even repentance and reformation liberate the unhappy victim."

"The consequences vary in degree and permanency, according to the extent of the indulgence and the constitution of different individuals. But there is probably no extent which is not in some degree injurious."

"How often has it happened that young men of rare promise, of whose success great expectations have been entertained, have suddenly failed by the way, have seemed prematurely worn down by study, and forced to relinquish the career on which they were entering with the brightest prospects. Little is it suspected by anxious friends or by a sympathizing public, in such cases, that it is not too excessive devotion to study; that it is not midnight toil; that it is not errors of diet, or want of air or exercise, that have withered their energies and unnerved their frame. There may be a nearer and more inevitable destroyer than these." (*Ware*, 13, *45* and *49*).

Some have tried to deter the young from this habit by affirming the peculiar and sacred nature of the function of reproduction, and the propriety of respecting its organs. But the natural answer is, that the reproductive organs are most nearly related, both in structure and in the course of development, with those whose offices are of all the most vile and filthy;

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and it is not easy therefore, to persuade a young man that there is anything peculiarly sacred in an organ which is at the same time a channel for a vile and poisonous excretion. But he may be made to see that that train of sensations culminating in the sexual orgasm, is some thing wholly apart from ordinary experience, and that it ought not to be aroused in any other than its legitimate and orderly way. In short, the *organs* are not sacred, but one of their functions is in itself pure, peculiar and not to be defiled.

The following extract refers to another form of self-indulgence, but it applies equally well to all those to which the young are so violently tempted by lack of other interests:

"Women who have sons to rear, and dread the demoralizing influences of bad associates, ought to understand the nature of young manhood. It is excessively restless. It is disturbed by vague ambitions, by thirst for action, by longings for excitement, by irrepressible desires to touch life in manifold ways. If you, mothers, rear your sons so that their homes are associated with the repression of these natural instincts, you will be sure to throw them into the society that in any measure can supply the need of their hearts. They will not go to public houses, at first, for love of liquor—very few people really like the taste of liquor—they go for the animated and hilarious companionship they find there, which, they discover, does

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so much to repress the disturbing restlessness in their breasts. See to it, then, that their homes compete with public places in attractiveness. Open your blinds by day, and light bright fires at night. Illuminate your rooms. Hang pictures upon the walls. Put books and newspapers upon your tables. Have music and entertaining games. Banish the demons of dullness and apathy that have so long ruled in your household, and bring in mirth and good cheer. Invent occupapations for your sons. Stimulate their ambitions in worthy directions. While you make home their delight, fill them with higher purposes than mere pleasure. Whether they shall pass happy boyhoods, and enter upon manhood with refined tastes and noble ambitions, depends upon you. Do not blame miserable bar-keepers if your sons miscarry. Believe it possible that with exertion and right means a mother may have more control over the destiny of her boys than any other influence whatsoever." (*Appleton's Journal*).

This is the place for reference to those who proclaim themselves by handbills, and in certain newspapers which find profit in a disreputable column, as making a specialty of private diseases and exhausted vitality. Judging in part from their own announcements, in part from the judgment of skillful practitioners of all schools, and in part from the statements of their victims, impoverished, hopeless and debili-

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tated, I do not hesitate to warn young men to keep clear of them; or, at least, to ask first the advice of the family physician, who, if he is unwilling to treat the case himself, can probably refer to some practitioner in good standing who is particularly well acquainted with the class of complaints above mentioned.

The dangers which attend the consultation of advertising quacks are described by Dr. Hall (*72, 342*).

"A letter is received from a young gentleman of high position, untarnished reputation, and high moral worth, active, energetic, and faithful in all the offices of trust in which he has been placed, and which he has never failed to fill with honor to himself, and credit to his friends. Such an one writes: 'I am satisfied that hell is my portion in robbing Nature and robbing God, my Creator. My mind is giving way to despair. I am ashamed of myself before my fellow-men and before God.'

"The practical question, and one which very nearly concerns every parent who has an unmarried son over fifteen years of age, is, What can produce such states of mind? They arise in all cases from a vicious reading; from perusing books which are sent gratis and post-paid by cart-loads, to all parts of the country every year, through the agency of the newspapers, with advertisements headed in this wise—taking a city daily, at this present writing—and which are copied, for large 'consideration,' by the country press, (nor

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are all of our religious papers guiltless of this damning iniquity): 'To the Unmarried,' 'Marriage Guide,' 'Physiology,' 'The Benevolent Association,' 'Physiological Inquiries,' 'Young Man's Book,' 'Warning to Young Men,' 'Manhood,' 'Physical Debility,' with a variety of other headings. These publications have the same aim, object, and end, and the midnight depravity which indites them stands out in every page. It is not necessary here to enter into minute details, but to make use of the general facts. The programme marked out by all of them is essentially the same. First, to pander to the vitiated curiosity of boys and youth, not only by the 'pictorial illustrations drawn from life,' but by speciousness of argument and reasoning and statements, to mislead the mind, inflame the imagination, corrupt the heart, and eventually degrade the whole character.

"It is an often remarked fact that, among the young gentlemen who attend a first course of medical lectures, there are many who imagine themselves the victims of each disease, as it is presented by the lecturer. And any person not versed in medicine can scarcely read a book on any disease, without beginning to imagine that he has many of its symptoms; leaving us to suppose that imagination has something to do in causing, or at least in aggravating, some maladies.

"It is not surprising then, that youths in their teens, or just entering manhood, in reading a treatise strong-

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ly depicting the ultimate effects of certain symptoms, alleged to be connected with certain conditions of the system, should run riot in their fears, and throw themselves helplessly into the hands of those who seem to know so much on the subject, and by their own accounts have had such remarkable success in their line. In every one of these books, without exception, certain symptoms are mentioned (not peculiar to any one disease, but common to a number, or which may exist, and, if let alone, would in time disappear of themselves) as peculiar to a state of the system indicative of 'a want of capabilities.' Among these the most stereotyped are, dimness of vision, loss of memory, inacpability of mental concentration, no steadiness of purpose, depression of spirits, etc. Then certain physical appearances are noted as corroborative of the existence of the malady in question. The youth, not having opportunities of comparing himself with others; not knowing that a good many of these very appearances are natural, or are not incompatible with perfect health, becomes alarmed, and in his fright appeals to the author of the book he has been reading, to save him by all means from the impending ruin and disgrace. A fee is extorted, which is up to the utmost ability of the victim to raise. Remedies are used. They do not change the condition of things, simply because the conditions are in many cases not unnatural; but the patient is made to believe that it is be-

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cause the case is more desperate than was imagined, and that more powerful and more expensive remedies must be used. These are alike unavailing; meanwhile, weeks and months pass away; the victim has spent all the money he can 'rake and scrape,' 'beg, borrow, or steal' literally, and then writes to some known physician in the strain of the letters already quoted, to make at least one more attempt at rescue; or if he does not this, he settles down in the despair which leads to suicide.

"But there is sometimes a more dreadful ending so far as mental and bodily sufferings are concerned; we say more dreadful with design; for it is more so in proportion as it is more of a calamity to die on the rack than by a cannon-ball. When the sharper has obtained all the money possible from his victim, and wishes to get rid of him, he says in plain language: 'There is no help for you but in marriage.' But often this is an impossible remedy, and even if it were practicable, the patient has such a view of his condition, that he would consider it dishonorable and even infamous to impose himself upon a confiding woman. The sharper is prepared for this, and with practiced depravity, advises an illegal connection, not only as a test of capabilities, but as a remedy for certain symptoms observed to occur in the early morning, or at the close of certain natural actions. Human nature can seldom withstand the motives presented in cases like

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these. Six months ago a gentlemen applied for advice under the following circumstances. He had been led, by reading a book on 'physiology,' to believe that in connection with certain practices a deplorable state of things was induced. He placed himself under the care of the writer of the book in question, and in two or three years had expended a considerable amount of money, without adequate results. He was then told that he must form a criminal *liaison*, which he did with inconceivable loathing, and which he maintained until he found himself the victim of a degrading disease, showing itself on the face and hands. To escape the inquiries of relatives and friends, he left home and came to us, the embodiment of despair, the mind hopeless, the body ruined, the constitution a wreck. This disease the writer has never treated in a single case; and it is always turned over to other hands, the usual advice being, when there is any hope of restoration, to have recourse to the family physician who would be more likely than any other to take a deep interest in the case, and exercise those sympathies which are so requisite under the circumstances.

"Cases of this kind are of daily occurrence, and are constantly coming under the notice of city physicians, by hundreds and thousands every year. Some practical lessons of an importance which can not perhaps be over-estimated, may be drawn from this subject:

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"1. Allow no paper or magazine to enter your house which offers, by advertisement, to send any book on health and disease free of cost. No man can afford to print a book for nothing, and then to pay postage on it, unless he afterwards finds his pay in the manner above described.

"2. Let all parents encourage the early marriage of their sons; as soon after twenty-one as circumstances will permit; it is a less evil than to be exposed to the dangers referred to, by putting it off to the more physiologically appropriate age of twenty-five.

"3. Let no youth ever consult a man at a distance for the ailments which have been described. Consult the family physician; him you can trust, as to body and reputation.

"As to the symptoms and debilitations of the early morning, which have such a depressing influence on mind and body, second only to those of dyspepsia, nothing can be more certain than that there is no remedy safe and certain in drugs; but it must be sought in the diligent following out of some active industrial pursuit, force of will, and the cultivation of a high and manly moral power, which looks with angry and impatient contempt on all that is vicious, corrupting and degrading, whether in deed, or word, or thought; this is the only efficient, the only infallible remedy, and is worthy of the mature reflection of every high minded and generous hearted youth."

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*Illicit Intercourse. Fornication.* Sad as are the probable results of self-pollution, they, in most cases, affect only the individual. The other form of sexual gratification to which it is necessary to allude always involves the wrong-doing of two persons, and its consequences may fall upon others wholly innocent of the sin.

It would seem that a work intended for young people should be free of even the mention of this evil, but so long as it exists, and so long as in some civilized communities prostitution is not only permitted but placed under government supervision, we cannot avoid a discussion of it.

Dr. Ware writes as follows: "Among the first lessons which boys learn of their fellows are impurities of language; and these are soon followed by impurities of thought. . . . . When this is the training of boyhood, it is not strange that the predominating ideas among young men, in relation to the other sex, are too often those of impurity and sensuality. . . . We cannot be surprised, then, that the history of most young men is, that they yield to temptation in a greater or less degree, and in different ways. With many, no doubt, the indulgence is transient, accidental, and does not become habitual. It does not get to be regarded as venial. It is never yielded to without remorse. The wish and the purpose are to resist, but the animal nature bears down the moral

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Still, transgression is always followed by grief and penitence.

"With too many, however, it is to be feared, it is not so. The mind has become debauched by the dwelling on licentious images, and by indulgence in licentious conversation. There is no wish to resist. They are not overtaken by temptation, for they seek it. With them the transgression becomes habitual, and the stain on the character is deep and lasting. . . . All testimony is united upon this one point—of the imminent danger to the health of early sexual indulgence. Neither is it alone the immediate production of disease which is to be feared; the constitution may be utterly and irreparably injured without this. The perfect development of our bodies, their firm and thorough organization, are prevented by it. Nothing tends more certainly to wither the energies of youth and blast the hopes of manhood. It is not merely that the mind is polluted; the body is enervated. A thousand forms of disease may hang around the victim, imbitter his existence or destroy his hopes in life, which he never imagines to have had such an origin."

"Providence seems to have stamped this vice with more than its ordinary token of displeasure, by rendering its votaries liable to that disease* from which

* Syphilis, the venereal disease.

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so few of them ultimately escape. The effects of this disease, as is well known, are not always to be eradicated. They are not confined to present suffering. They may set a mark upon a man as indelible as that of Cain. They may cling to him through life, may destroy his health, undermine his constitution, hasten his death; may even terminate in disfigurement and mutilation. Nay, they may even so taint the blood as to descend to his very offspring, and inflict upon another generation the fearful consequences of his transgression." (*Ware*, 13, *44*. See, also, *Ellis*, 45, *31*).

By intercourse with any person, the man whether married or single defrauds his wife, present or to be, of what belongs to her alone. No doubt there are degrees of criminality herein. But, aside from the law, from Christian custom, and from Divine injunction, common sense, and the analogies drawn from animals, indicate that the highest and purest relation can prevail only between *one man and* one *wife*. (41). And although Mormonism, "Communism," free-love and seduction may less often produce disease, yet, for obvious reasons, all of them are liable to degenerate into that curse of all large communities, indiscriminate prostitution.

There are those who would palliate occasional lapses from chastity by urging the force of their natural passions, the heat of their blood, and their superabundant animal spirits; they would have us infer

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from history, both ancient and modern, that this kind of indulgence has prevailed in all times, and they point to some passages in old works which seem to describe fornication, especially with a single person, as less injurious, morally and physically, than absolute continence. They even offer evidence to show that with young and vigorous men the appetite could not be wholly restrained without damage to body and mind.

But it must be remembered, in the first place, that the accepted codes of morality were not the same then as now, and that therefore what all now know to be sinful may then have been regarded as comparatively harmless. The same allowance must be made for some, at least, of our ancestors, that is now made for uncivilized communities. We must, in common charity, allow that those who err in ignorance are less guilty than those who wilfully disobey.

Refraining, however, from a discussion of this point, since it involves metaphysical and theological considerations, let us confine ourselves to that part of the excuse which is based upon alleged physical necessities.

Who and how many are they that are now unable to restrain their animal passions? Surely they are very few at this day, however numerous they may have been a century ago. For at that time men were large, full of blood and animal spirits, comparatively



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coarse in organization, and able to do and to endure what is beyond our powers. They worked harder, they drank deeper; they had less brain and more blood. Many, even within our remembrance, were annually bled, and the change in respect to this and strong dosing is not merely a temporary revolution in medical practice, but is due quite as much to a real and recognized change in our physical organization.* In some respects we may not be the better off, and there is certainly danger for ourselves and our descendants unless some limit is set to the excessive nervous and mental activity which is so general and almost unavoidable.

But in regard to sexual impulses, while the change has brought relief in one way, it has imposed responsibilities not before incurred. Formerly lust was born of the *blood;* the very robustness of health was a temptation; the flesh was mighty and the spirit was weak; and the remedies were corporal and violent, like the disease. We may even charitably admit that there were some cases in which only blood-letting

*Prof. John Fiske is of the opinion that "the slow alteration of *physique* which is going on in this country is only an exaggeration of that which modern civilization is tending to bring about everywhere. It is caused by the premature and excessive strain upon the mental powers requisite to meet the emergencies of our complex life. The progress of events has thrown the work of sustaining life so largely upon the brain that we are beginning to sacrifice the physical to the intellectual. We are growing *spirituel* in appearance, at the expense of robustness.

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could, for a season, stay the raging fires of bodily passion.* But it is not so now. Our foes are still of our own household, but they are the eyes, the ears, the brain, the thoughts, the imagination, all those finer organs and subtler processes which our conditions of life stimulate into highest activity; and *these we can control to an extent impossible in the other case.* We may avert the eyes from the indelicate, and close the ears to the obscene.† We may will that the brain shall invent labor-saving machines, and solve problems in

*This excuse, however, can hardly be accepted as valid without regarding the tendency as a *bodily disease* like inherited or acquired *dipsomania.* Perhaps in the same category should be included the cases in which the beginnings of vicious habits can be traced to uncleanliness. "The congestion of hemorrhoids (piles), the presence of Ascarides (worms) in the rectum, the existence of constipation, are all of them agencies which, by their reflex irritation, determining an abnormal excess of blood to the parts, and inducing a state of hyperæsthesia, or undue nervous excitability, may give rise to procedures which, in the same individual at other and more healthy seasons, would cause for him but the most revolting disgust." (*Storer*).

†Yet this is not always easy, for "we see on every news-stand illustrated books and papers familiarizing the public mind to indecency; the periodicals of widest circulation are filled with tales of morbid sentimentality; and not a few, through their advertisements, offer concealment and aid to debauchery." (*Napheys*, 46, *321*).

There are occasionally cases of alleged sexual immorality, affecting persons of such position as to apparently justify respectable journals in referring to them. But who can estimate the degree in which the public moral sense is blunted by the daily presentation of disgusting details of evidence?

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science, in place of scheming how innocence shall be entrapped and lust be gratified. Our imagination may be encouraged to aid our efforts toward the good and the pure, rather than the evil and the impure.

And while, no doubt, there are greater dangers from perversion of these faculties, and from the widespread dissemination of evil books and pictures and filthy newspapers; yet, as already said, these are influences from which we can flee, and to which there is no excuse for our yielding; not even the excuse of our forefathers, for it no longer exists with us.

*Fighting Temptation.* To all men this peculiar temptation is sure to come, sooner or later, in one form or another. I say to every *man;* in our precocious times it comes too often to boys, even to children. Were these matters discussed as they should be between parents and children, the latter could and would ask help from the former, but so long as the old keep silence the young cannot be expected to speak; and the best help we can offer is the following extract from a Cambridge (England) graduate, quoted by Dr Storer:

"The sufferings of an abstinent life I believe to be *cruel* to every man between twenty-five and forty-five years; and though athletic exercises, regular diet and so forth supply some slight relief, still it is never permanent, and in any event of reaction the sufferer will find himself the worse for his previous regularity. Of

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course a sedentary life aggravates the symptoms, and I cannot believe that any man of ordinary vigor, so living and so abstaining, will be free from nocturnal annoyance. Still this would be among the least of his distresses; nay, in nine cases out of ten I presume the safety-valve of nature is a most happy and beneficial relief, and though I cannot fly in the face of medical authority and deny that there is a pernicious class of the disorder, still I firmly believe all those cases immensely exaggerated by the sufferers, and capable of an easy cure, to wit, matrimony, unless the patient, by degrading practices, has reduced himself to a state of impotence.

"Meanwhile, a man should go into training for a conflict with his appetites, just as keenly as he does for the University Eight, the only difference being that the training will be more beneficial and more protracted. Besides diet and exercise, let him be fully employed; in fact, let him have so many metaphorical irons in the fire that he will find it difficult to snatch ten minutes for private meditation; let his sleep be very limited," (I am not sure of his being right there), "and the temperature he moves in as nearly cold as he can bear; let neither his eye nor his ear be voluntarily open to anything that could possibly excite the passions; if he see or hear accidentally what might have this tendency, let him at once resort to his dumb-bells, or any other muscular

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precaution, till he is quite fatigued; whenever any sensual image occurs involuntarily to his mind, let him fly to the same resource, or else to the intellectual company of friends, till he feels secure of no return of on his enemy's part.

"Lastly, I would fain add, let the sufferer from sexual causes make his affliction the subject of most earnest prayer, at any and all times, to that ear where no supplication is made in vain. Thus armed, he may keep his assailant at bay, though I fear conquest is impossible and the struggle a most severe one.

"Sound old Jeremy Taylor, after discoursing on chastity in something like the above strain, says, if I remember right, 'These remedies are for extraordinary cases, but the ordinary remedy is good and holy marriage.'"* (*Storer*, 9, 74).

I do not believe that Taylor meant a wife to be regarded as a vial of medicine so labeled; and surely women would revolt from such a view of the uses of marriage. Nor would it be unwise for them to insist upon a pledge that the intended husband had never incurred any of the risks, or contracted any of the

*The following decided expression of a competent observer is entitled to careful consideration: "Bachelorship is more destructive to life than the most unwholesome of trades, or than residence in an unwholesome house or district, where there has never been the most distant attempt at sanitary improvement of any kind." (Dr. Starke, Register General of Scotland, quoted in N. Y. Med. Journal, Dec., 1869, p. 297).

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diseases incident to illicit or abnormal gratification of the sexual instinct. There would be fewer marriages, but the few would be happier; fewer children, perhaps, but more healthy boys and girls. Individuals might seem to be the losers, but the world would gain in health, beauty, strength and usefulness.

The advice given by Taylor and others should rather be interpreted thus: You who feel the sexual instinct strong within you, and who love truly, but who defer or abstain from marriage on worldly grounds, had better run the risk of poverty than of immorality; and had better marry, provided your intended wife can know all the circumstances, and assent with full knowledge.

But it must be remembered that "'Many persons fancy themselves in love, when in fact they are only idle;' and, therefore, for all young people, idleness is the thing most to be avoided, since the sham of love coming prematurely, is of all things the most contemptible and dangerous. But some persons never 'fall in love' at all; they walk into it blindfold, and then awake suddenly with wide-open eyes, to find that all the interest of life is concentrated in one person whom they believe, truly or not, to be the best person whom they ever knew, and whom they could no more help loving than they could help loving the sun for shining on them, and the air for giving them wherewithal to breathe. This is not 'being in love,' or

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being 'made love to.' It is love, pure and simple, the highest thing, if often the saddest, which a woman's heart can know."

The above is from Mrs. Craik's (Miss Mulock's) last novel, "My Mother and I—a Love Story for Girls," and I cannot forbear adding the earnest wish that all young persons would read as many as possible of her stories, especially "John Halifax" and "A Life for a Life." They are novels and love stories, but they are interesting, and are worth, for the young especially, ten times their bulk of doctrinal discourse and abstract moralizing. The same may be said of Patmore's "Angel in the House." Indeed, many of the standard novels, as those of Scott, Dickens, George Eliot, the Kingsleys, Charles Reade, Wilkie Collins, so well combine a good purpose with real human interest that they will be read in spite of all prohibition, and even on account of it. And the over-anxious parents may find, to their sorrow, that their uncalled-for injunction has occasioned a habit of concealed reading which is very liable to include really pernicious works.

The same effect is produced as by exaggerated tem perance exhortation. When a boy is told that all things containing alcohol are poisonous, and lead inevitably to dram-drinking and drunkenness, he may try to think so to please his instructors. But sooner or later he learns, by his own furtive experience or that of others, that the statement is essentially false; and having once be-

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gun to drink in secret, even though it be the lightest of wines, soon concludes that since his advisors were wrong as regards some alcoholic drinks, they are likely to be in error in regard to all. And he becomes a tippler because reason and experience have disproved the original and erroneous, although well-meant, instruction. That the same idea applies to instruction upon the general subject of this work, will be indicated in the Appendix. I would simply add here that if parents wish their children to avoid bad books they must take the pains to supply them with others which are at the same time good (but not "goody") and *interesting*.

"Another safeguard is to be found in the cultivation of a just perception of the true relation of the sexes. Let the young man cherish a high estimate of, and reverence for, the character of the true and pure woman, and a corresponding detestation and horror of her who abuses and prostitutes the privileges of her sex. The young man who looks forward to a legitimate and permanent union with a congenial and virtuous woman, will find in the hopes and prospects which it opens to him in life, the surest defence against the temptations which continually assail him from without and within." (*Ware*, 13, *65*).

Among young men, and even boys, it is accounted smart and knowing to speak loosely and slightingly of virtue, and especially of woman's purity. No doubt

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there are occasions for this; but even these sad cases are almost invariably the *direct result of some man's misdoing*, "and I have never hesitated to consider the victims of seduction generally as sinned against rather than sinning. Despite all the spread of knowledge, advisable and unadvisable, there still exist many unmarried women, not only entirely innocent of improper act or thought, but foolishly, inexcusably ignorant concerning matters which their mothers should have taught them." (*Storer*, 9, *140*).

No doubt there are foolish girls apparently bent only upon attracting the attention of young men. But it is mere foolishness and vanity, and could they know the evil ideas and emotions which too often lurk behind the admiring glance, they would rather wear sackcloth all their days than be the objects of it.

With very few exceptions, the minds of women look upward at the beautiful and the good, however much vanity and frivolity may intrude from inheritance or association. But the minds of men, while apparently capable of loftier intellectual flights, are apt, at intervals, to drop helplessly to the unstable ground of *double entendre*, or even to sink into the mire of indecent expression. At the worst, a feminine association is animated at times by a spirit of gossip. But in nearly every place where men alone do congregate, whether street-corner or liquor saloon, barracks or medical lecture-room, club parlor or society hall, there are spoken

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words which show that where men are gathered together without women, the Devil is apt to be in the midst of them.

"Purity of language in the intercourse of society should be regarded as an essential quality of the gentleman, and the want of it should exclude him from good company, as much as any other vulgar habit." (*Ware*, 13, *64*).

If the mark of a true gentleman is that he says nothing with men that he would not utter before women, then the test of inward purity should be that he thinks nothing that might not be uttered before mother, or sister, or wife.

None but the most depraved can endure an evil thought, much less an evil speech, concerning the character of mother, sister or daughter. Let us bear in mind that *every woman is the daughter, and may be the sister or mother of other men, and do by them as we would be done by.*

*Concluding Remarks.* Much more might be said upon the moral and religious aspects of the subject. But these have been presented by others, and my object is to furnish what is not usually given, namely, the anatomy and physiology of the reproductive organs.

Still, I am willing to express my conviction that any deviation from the conduct most favorable to health does, as regards the sexual relation, involve some form of immorality: which is sometimes recog-

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nized and punished by the law, but more often only by the offender's conscience, and by the silent contempt of his virtuous acquaintance.

Nor do I admit that for any such deviation, however slight, there is sufficient excuse, either in our own inherited tendencies, or in our training, or in the circumstances in which we are placed. For I believe that no one is ever exposed to temptations which he cannot resist and overcome, *if he will;* that whatever may be the evil tendencies which we inherit from our frail ancestors, Providence has given us strength to rid ourselves of them; that therefore we, and we alone, are responsible for each and every lapse from virtue. To ascribe our backslidings to fate is superstition. To blame the Almighty for our sins is blasphemy. Nay more, those who excuse themselves upon these grounds to others, or even to themselves, know in their inmost hearts that they are telling a lie; that the fault is theirs, and that they alone are to blame.

I shall be glad if the foregoing pages shall furnish to the well-disposed a better basis of knowledge for well-doing, and awaken others to a sense of the harm their errors are bringing upon themselves and upon others.

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# APPENDIX—A.

"It is a delicate subject which the foregoing treatise embraces, but it is one which cannot be unknown. When we are little boys and girls, our first enquiries about our *whence* are answered by the authoritative dogma of the "silver spade;" we were dug up with that implement. By degrees the fact comes forth. The public, however, remains for ages in the silver-spade condition of mind with regard to the science of the fact; and the doctors foster it by telling us that the whole subject is a medical property. Our author wants to tell us, on the other hand, all about these mysteries; and we suppose the time has come when we may begin to know. There is nothing wrong in the knowing; and, though the passions might be stimulated in the first moments by such information, yet



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in the second instance they will be calmed by it; and, ceasing to be inflamed by the additional goad of curiosity and imagination, they will cool down under the hydropathic influences of science. Well-stated knowledge did never yet contribute to human inflammation · and we much question whether the whole theory of the silver spade be not a mistake; and whether children should not be told the truth from the first; that before desire and imagination are born, the young mind may receive in its cool innocency, the future objects of powers and faculties which are to be subject afterwards to such strong excitements. Vegetable generation supplies a beautiful and most decorous set of analogies for instruction in animal and human. But, we repeat, it will not be the great doctors, as such, but the great educators, from whom whom this information, suited to the public and to the children, can be obtained." (*Wilkinson*, advertisement of 81, *viii*).

With some, the foregoing may be a sufficient answer to all arguments in favor of perpetuating the silver-spade theory; but, as specific objections are likely to be urged against the propriety of the present publication, it may be well to consider them in detail. They are as follows:

1. *That the whole subject is improper and should not be discussed at all.*

This sweeping objection is merely the verbal ex-

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pression of the sentiment which induces most good people to wholly ignore the "science and the art of propagation," or to refer to it only in respect to their cattle. No intelligent farmer raises his horses, cows, sheep or even swine as carelessly as he perpetuates his own species, and the inevitable result is that many a man finds his old age more happily spent in the care and contemplation of his well-bred flocks and herds, than in the society of his children. For the latter were begotten when one or both partners were "out of sorts;" when there was spiritual coolness or estrangement between them; when neither was in that condition of mind or body which could be wished perpetuated in the offspring.

This objection is embodied in the prescribed celibacy of the Shakers and of some clergy; and these affirm that warrant for their belief exists in the sacred Scriptures. But so long as they are in the minority, and so long as many passages distinctly sanction sexual intercourse, we hardly need assume upon scriptural authority, that the reproductive organs themselves, or their functions, are immoral in their nature. Indeed, there is no intelligible account of the production of human beings by any other than the generative act.*

* I mean that I find myself unable to conceive the production of human beings directly from the "dust of the earth;" while, on the other hand, it is not difficult to imagine that the first creatures were such simple *unorganized* organisms as we now find upon the earth, (structureless, yet liv-

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2. *That Scripture contains sufficient information.* No one will question the minuteness of the injunctions and prohibitions laid upon the Jews through Moses; and modern customs and laws have in the main accorded with them, as far as regards this kind of evil doing.* But there are very few who now feel called upon to conform to each and every one of the directions; while the fact that the Mormon and Shaker, priest and polygamist, all profess to have Divine authority for their very diverse practices seems to warrant us in looking elsewhere than to the mere letter of the Word, especially as now translated. Indeed, the world is slowly but surely coming to see that the literal sense of the Bible cannot be accepted as a full and sufficient treatise upon any subject of human in-

ing masses of protoplasm, like the Moners, etc.), and that, under law, by either ordinary generation, or, as suggested by a late writer, (*Ferris*, 29), by *extraordinary* generation, without the coöperation of the male, the other and higher organisms were successively produced; so that man himself, though indirectly and after a long interval, is created from the dust of the earth by Almighty power. Nor do I shrink from the conclusion that the human body, (the *soul* is another thing), has been born from some ape or ape-like mother; especially while there are "many men of whose parentage a respectable baboon would be ashamed." It is worth considering that the very quality which first impresses us in the monkeys, namely, *imitativeness*, is one to the exercise of which is due the marvelous rapidity with which children learn, as compared with the young of all other Mammals.

*The concordance between the Mosaic rules and the precepts of modern medicine is shown by Napheys, (46, *305*).

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terest. Neither its law nor its architecture, its natural history nor its engineering are regarded as absolute authority. And while we may believe that the *spiritual sense* is a perfect record of man's spiritual creation and progress, we may fairly doubt whether the Creator ever intended that the Bible should serve as a literal history of the physical universe to the exclusion of that other revelation, Nature.

3. *That Nature is a Sufficient Guide.* One of man's boasted prerogatives is to be governed by reason rather than by instinct. Yet, in the exercise of the reproductive function, which has most intimate relation with the well-being of ourselves, our wives and children, nay, even our children's children, we set reason aside and blindly follow instincts which, in too many cases, lead to depths of degradation into which no beast could enter. For *no male animal offers violence to the female.*

It is affirmed that "a larger share of sorrow, poverty and vice depends upon the want of proper education in respect to the legitimate uses of the reproductive organs and upon their illegitimate uses than upon the perversion or improper indulgence of any other human propensity."

4. *That this subject is too delicate and difficult to be presented with advantage, or even with safety, to the minds of the young.* "It is the opinion of many that to inform them concerning it, is to expose them to its

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dangers; that, since the purest minds are those that dwell the least upon it, it is wisest to leave the young as far as possible in this state of purity, and trust to the chances of life that it may remain so. By seeking to enlighten we may lead the thoughts where it is always dangerous for them to wander, and rouse sentiments which might otherwise slumber till the period of life arrives when it is right that they should be developed."

"But, putting aside the question whether we ought to hide this subject wholly from the young if we could, the truth, it is to be feared, is that we cannot if we would. Admitting it to be desirable, every man of experience in life will pronounce it to be impracticable. If, then, we cannot prevent the minds of children from being engaged in some way on this subject, may it not be better to forestall evil impressions by implanting good ones, or at least to mingle such good ones with the evil as the nature of the case admits? Let us be at least as wise as the crafty enemy of man, and cast in a little wheat with his tares; and among the most effectual methods of doing this is to impart to the young just and religious views of the nature and purposes of the relation which the Creator has established between the two sexes." (*Ware*, 13, *11*).

But it seems to me that some knowledge of the physical nature of the two sexes, and of the differences in their powers, should accompany, if not pre-

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cede, the moral and spiritual part of the subject. Just as some acquaintance with the nature and habits of animals forms the best foundation for instruction respecting their representation of, or correspondence with, certain abstract qualities.

Forbidden fruit is sweet, and we hanker after it. Much of the interest in, and support of, secret organizations* is due to the mystery which surrounds them, and occasions curiosity on the part of outsiders, and imparts a puerile gratification to those within the sanctuary. And we may be sure that most of the prurient curiosity respecting the reproductive function would be avoided, if the whole subject were calmly and soberly presented, like any other important and obscure physiological topic.

This curiosity is aroused and propagated from youth to youth by half-spoken hints and innuendoes. It is a virulent epidemic, and while I would not deny that in the distant future mankind may reach such a state of purity as to need no such remedy, at present I am convinced that the only means of checking its ravages is by sober and complete information—a kind of mental *inoculation.* The aim of parents and instructors should be to *prevent the exercise of the imagination* upon the bodily organs; to impart as clear and realistic an idea of them as possible, so that noth-

* See 58 and 59

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ing is to be even guessed respecting their structure and their functions. Only then will it be possible to restrain the imagination to its legitimate action respecting the mental and spiritual natures of the other sex.

In many cases, too, the minds of college students have already been excited by classical indecencies. "The youth gloats over the pleasures which the heathen deities are supposed to have indulged in, while his imagination runs riot amid the most lascivious passages. The doctrine laid down in these volumes seems to be, that lust went on unchecked, that it was attended with no evil results, either physically or morally, to the individual or to the society in which such scenes are supposed to have existed. He reads of the pleasures, nothing of the penalties, of sexual indulgence; and it is at a later period that the poor schoolboy learns that sexual pleasure is not to be indulged in with impunity. He is not intuitively aware that, if the sexual desires are excited, it will require greater power of will to master them than falls to the lot of most lads; that if indulged in, the man must and will pay the penalty for the errors of the boy; that for one that escapes, ten will suffer; that an awful risk attends abnormal substitutes for sexual intercourse; and that self-indulgence, long pursued, leads ultimately to early death or self-destruction." (*Acton*, 38, 17).

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The author just quoted suggests no substitute for the works whose employment he condemns. Perhaps there are none to be found. But as the taste for scientific and philosophic studies increases, perhaps the charming writings of Aristotle and Pliny the elder, upon natural history especially, can replace the objectionable works. And even if not, I cannot see why students should be required or even allowed to read in a dead language that which would be thought indecent if printed in their own.

It is, no doubt, a matter of grave consideration at what age young people should be fully informed upon this subject. There are many things which even children can understand and profit by; but such instruction should come to them through their parents, if possible. Perhaps the same course is to be preferred with boys and girls, at home or in the common schools, where, as a rule, they are more or less under parental supervision.

But when the young people leave home and enter college they take a very long step. To a great extent they are independent of home influence; they must choose their own companions and form their own habits of thought and action. Practically they are men and women, and soon will find themselves exposed to all the evils and temptations likely to assail them throughout life. Sooner or later most of them will learn all that they can about the generative

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function, and for this reason, *sooner rather than later*, should they be fully informed respecting it, as a part of their physiological instruction.

Let those who think otherwise point out the age when a student should know any given branch of this subject. The fact that no two can agree as to just what should or should not be told at a given age is of itself an indication that no natural limit can be assigned between the two extremes, *nothing* and *the whole*.

Perhaps the time has not yet come for carrying the above idea to its logical conclusion and presenting to the young a scientific description of the whole matter. But the longer I think of it the more convinced I am that after the first excitement of the revelation they would then be safer from impure thoughts than at present, when this, the centre of natural interest, is ignored, or vaguely hinted at, as in most works upon physiology. The above conviction is more plainly expressed in the following propositions:

1. The generative act is at some time an absolute mystery to all persons.

2. To nearly all it appears as a mystery which, sooner or later, is to be solved. The solution thus has an intense personal interest which impels inquiry.

3. Custom forbids an open inquiry of parents and compels the seeking of hints from vicious companions and books, and the filling up of the gaps by the im agination.

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4. The result of this is to direct an emotional attention upon the sexual organs and their functions at the very time when their normal and gradual development should occur.

5. All difficult questions cease to command undue interest when their answer is plain and unmistakable.

6. If, then, the youth can have the whole subject made clear to him, and understand that the normal reproductive functions are simply a difficult branch of physiology, he is likely to be spared any undue curiosity, or morbid exercise of the imagination.

A clergyman writes as follows:

"Children's queries as to whence and how the baby came are entitled to straightforward, satisfying answers. It is right and proper for them to ask; it is also right and proper for their elders to tell truly, simply, clearly, with tender seriousness and reverence too. Give young people (from the very outset) definite as well as ennobling views of sexual facts and duties.

"The subject is sure to be thrust upon their attention sooner or later, to be canvassed either openly or clandestinely, with the upward or with the downward look. Then let their first impressions (which are proverbially the abiding ones) come fresh and sweet from the wise and good, not foul and poisonous from some ignorant and corrupted source.

"We hope that the anatomy, physiology and hygiene of the reproductive system (together with the

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principles of heredity) will be prescribed ere long as a chief study for youth of both sexes and taught by pure minded and otherwise competent teachers throughout our common schools." (*Boyd*, 98).

5. *That such instruction should be left for parents.* This is readily granted as an abstract proposition, nor can I imagine a higher use than the full explanation of this subject by father to son, by mother to daughter. Yet so little is this acknowledged or acted upon, even in the simple and wholly personal matter of menstruation, that "many a frightened girl has resorted to every conceivable device to check what she supposed to be an unnatural and dangerous hemorrhage, and thereby inaugurated derangements which have terminated her life or enfeebled her womanhood." (*Foote*).

And so grave are the errors of ignorance in the married relation, that in my opinion to encourage or even to allow young people to marry without having received such instruction, is as foolish and wicked as to place in the hands of a child a loaded pistol or a paper of poison, for no other reason than that it wanted them and had reached a certain age, and yet to offer no word of advice or warning respecting the dangers of their employment.

"But, alas! how few parents, how few instructors, have the knowledge, the discretion, the tact, the judgment, to qualify them for such an office!"

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"The dangers under which we lie from hatred, envy, malice, anger, covetousness, worldliness. are distinctly pointed out to us. But in regard to this particular propensity, an utter silence is maintained."

Too often, therefore, as children, "we are left to enter into the midst of fearful temptations, unwarned and uninformed. We receive our first impressions on this subject from our companions, and there is ground to fear that the teaching on this very important topic is wholly in the hands of those whose ideas in regard to it are low and gross." (*Ware*, 13, *6*, *7*, *8* and *9*).

Until, therefore, parents feel it an essential part of their duty to acquire this information themselves from reliable sources, and to impart it fully and freely to their children as soon as it can be comprehended by them, no teacher of physiology can hold himself wholly guiltless of the sins or misfortunes of those under his charge if, from mistaken delicacy or other motive, he refrains from including in his instruction an account of the generative organs, their legitimate uses and the perils which attend their abuse.

Yet some of our "Physiologies for schools and colleges"* make no reference even to the kidneys, and

* The following paragraph from the preface to a recently published "Manual of Comparative Anatomy" is a fair example of unscientific prudery: "This book being published as an introduction to the study of Comparative Anatomy for the use of *schools*, it has been thought advisable to omit all special reference to the generative system."

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the large majority ignore the existence of the reproductive function, while none in the English language contain a sufficient account of the subject. The reproductive organs and processes of plants are favorite subjects of study, but those of animals are excluded.

The physiology of the present day is selfish, and refers mainly to the present and its needs. We are taught how to eat and drink, how to walk and breathe, all these things being primarily for our own benefit, and only indirectly for the good of our descendants. The interests of the latter ought to receive a larger share of our attention.

It may be too soon to expect the inclusion of this subject with the lectures upon physiology in our educational institutions, but one of the extracts already given (page 168) shows that others are looking in this direction.

There are obvious practical objections to oral instruction, especially with mixed classes and upon certain parts of the subject, and it will probably be better to recommend suitable works for reference.

6. *That there are already many works upon the subject.* This is true, and I have examined many of them. But, while some of them are without illustrations, or contain no anatomy and physiology, others include ideas and recommendations which may be injurious. A few are the efforts of "holy and well-meaning men to turn men to better ways by fervent

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descriptions of the wrath to come; but others are rather the attempts of unprincipled empirics to terrify the masses by over-drawn pictures of disease." (*Storer*, 9, *21*). In short, none of them were prepared with reference to the needs of students and other young people who wish to obtain a systematic view of this branch of physiology.

7. *That sufficient information may be gained from the larger physiological works, and by attendance upon medical lectures.* So far as I know, the kind of information which is needed is not readily to be obtained from either of above sources. Some of it is such as the instructors would hardly venture to present to a large class under the existing conditions as to conduct of students in most medical schools. And it is evident that to the general public medical lectures are not accessible. The same is true, in a less degree, of the larger medical and physiological works the size and cost of which limits their general circulation.

But even were this not the case, we consult those works in vain for an extended and systematic account of the structure, and functions, and hygienic laws of the reproductive organs. The first is given with, for ordinary purposes, unnecessary minuteness in the larger Anatomies. The second is treated with more or less detail, but generally in a one-sided manner, by the Physiologies. While of the third, almost nothing

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is said in these two classes of works, and the manuals of midwifery contain only a partial view of the subject.

It gives me great pleasure to mention the last volume of Dr. Flint's great work,* as meeting the requirements of the case more fully than any other in the English language, but even this falls short in respect to hygienic suggestions.

8. *That the illustrations are objectionable, and the language so plain as to offend delicacy.* If the figures here given are objectionable, so they are in the works from which all are copied, and much more so are the organs which they represent. It by no means follows, however, that the figures are to be displayed on all occasions, any more than it would be agreeable to witness all the various stages of digestion. Yet there is nothing immoral in the latter, and all admit that we are better off for a thorough acquaintance with the process.

It should furthermore be remembered, that even our standards of delicacy are more or less variable and artificial; and that there are those, most estimable persons in other respects, who shrink from hearing the "naked" truth, even respecting the "leg" of a table.

As to the plainness of the language, it must be borne in mind that an especial purpose of this publi-

* The Physiology of Man. Vol. V, Special Senses and Generation.

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cation is to remove the sentimental glamour which has hitherto surrounded the whole subject; to impress facts and ideas upon the *memory* so clearly that the imagination shall not be required to complete the picture. For this, nothing seems to me more desirable than the calling of things by their right names.

There remains to be considered but one more objection.

9. *That it will tend to lower the sentiment of love in the minds of the young.* If this objection were sound it would be fatal. For I hold that true conjugial love, the eternal bond between one man and one wife, is "heavenly, spiritual, holy, pure and clean," the highest of all human affections; and that therefore its defilement is the worst of sins.

In the minds of many people *marriage* equals *lust plus convenience* or *pecuniary advantage.* With such, a plain account of the reproductive process seems to dispel that weakly sentimentality so widely inculcated in certain novels and periodicals, which forms the only redeeming feature of their passion. The sooner such mischievous poetry is exorcised by a dose of sound physiological prose, the better for us all.

But true love is related to the physiology of the reproductive organs only as is a friendly embrace to the muscular contractions which perform it; or a social meal to the process of digestion. The one depends upon the other, and is manifested through it,

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but they are as soul and body. The one is as high above the other as are the heavens above the earth.

My readers are especially desired to disconnect the subjects herein presented from whatever sentiment they may entertain respecting individuals, or the other sex in general, and to only consider what their organs are, what is their legitimate use, and how to avoid their abuse; pursuing this branch of physiology as soberly and as unsentimentally as they would study the circulation or the functions of the nervous system.

He who can bring himself to do this may hold himself forever free from that dangerous yet common delusion that one is *in love* merely because the reproductive organs are deranged, and may safely await the advent of her whose presence arouses all the highest and purest emotions, and toward whom, until after marriage, no lower manifestation is possible, even in thought.

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# APPENDIX B.

## *Views of Claude Bernard respecting the resemblance between embryonic evolution and the evolution of redintegration.**

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All the phenomena of living beings have a common origin, the cell. The cell and the ovum are constructed upon the same type. The egg divides, segments and produces an infinite number of cells. The phenomena of prolification are at their greatest activity in the embryo. We shall show that cellular multiplication also exists and continues in the adult.

The researches of Schleiden upon the vegetable tissues, those of Schwann upon animal anatomy have been the basis of the present ideas respecting the cellular elements and their office in the development of tissues. There is a period of embryonic life when the new being is made up only of cells called the embry-

*See Preface, and Bernard (108).



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onic cells, namely, at the moment of the formation of the blastoderm. At a later period the cells differentiate and thus provide for the production of the various anatomical elements. The organism composed of cells is sustained only by their constant renewal. These cells develop themselves so as to produce the different organs. We shall say a few words upon the laws which govern their development.

When we examine the primitive cell, the egg, we see, after fecundation, that it segments and gives rise to elements like itself. These primary cells which result from the division of the egg are the embryonic cells. All the organs pass through this state. With an embryo already formed, that is to say, when the trunk, the limbs and the main outlines are recognizable, the muscles, the liver, the kidneys, are distinct as to form; but, if we take these organs and examine their structure we find that it is identical in all; they are all composed of embryonic cells. The form of the organs precedes the details of their structure.

Thus every tissue begins by being formed of embryonic cells, and is organized by the transformation of these primitive elements. But how then does this embryonic cell give rise, one after another, to the different tissues?

According to a theory adopted in Germany, one cell can transform itself into another, one tissue into another tissue, a cartilage cell into a bone cell.

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The works of H. Müller and Ranvier upon the development of bone have shown, on the contrary, that neither the cells nor the tissues are capable of being transformed directly into other tissues or cells. It is not the same element which passes directly from the first form into the second; there has been an intermediate evolution. When a cartilage is about to ossify, the cartilage cell is destroyed, disappears, and returns to the embryonic condition, and it is from this last that it becomes a bone cell. This law applies to all cases of this kind to such an extent that we may say that the phenomena of regeneration take place by a return to the embryonic condition which always marks the commencement of repair or of metamorphosis of tissue.

These phenomena occur by virtue of two principal conditions, one being the autonomy of the elements, the other the influence of the region in which they live and are evolved. We have been accustomed to overestimate the importance of the first of these conditions, and to underrate the second. We have had a wrong idea respecting the autonomy of the elements, which has been declared to be entire and absolute. The different cells of the body of an animal are not absolutely independent elements; sprung from a single cell, the egg, which has imparted to them a particular nutritive and reproductive [parthenogénétique] property, they bear the stamp of this common origin which forms a bond of union between them; they are



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always subject to the influence of this prior state, which explains and affects their actual evolution. Undoubtedly they have a certain activity of their own; each has special conditions of life, of death, of reactions and of poisoning. But this independence has its limits; it stops at the point where elements tend to become distinct organisms.

The experiments upon which we base the idea of autonomy are very remarkable; especially those relating to the development of osseous tissue. The works of Duhamel and of Flourens have taught us that bone is formed at the expense of the inner layer of periosteum. We know now that this is through a progressive and retrogressive evolution of embryonic cells which exist under the periosteal membrane; but it is through the experiments of Ollier that the autonomy of these elements has been most clearly exhibited. Taking a bit of periosteal membrane retaining its inner layer of young, newly-formed cells, M. Ollier transplanted it to a region where no bone existed, under the skin of the back. The fragment of periosteum developed, ossified, and gave rise to an osseous formation. These elements have then a life of their own, to a certain extent independent of the medium in which they are.

Yet that conclusion is not rigorously correct. The studies upon the same subject have led to the conclusion that the influence of the region has no less an effect upon the development and final condition of the

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tissues. This second part of the demonstration is due to various experiments, and particularly to those of Philippeaux. Repeating the experiments of Ollier, Philippeaux has shown that if the observation be continued for a longer time the new bone, formed from transplanted periosteum, gradually disappears, is reabsorbed, and that in its place is found only the proper tissue of that region. In that second phase of the experiment, the activity peculiar to the elements has given way to the influence of the region.

There is another experiment due to Ranvier, and which we must interpret in the same sense. Taking a very young animal Ranvier removed a metatarsal bone and grafted it upon the skin of the back. The little bone grew at first, but did not fail afterward to undergo the phenomena of retrogression, and in its place was to be found only the tissue of that region. Meantime, in the place of the removed metatarsal a new bone had appeared.

Certain organs manifest in their functions oscillations of greater or less extent, in the intervals of which they atrophy and seem to diminish. We have already mentioned the continual shedding of epithelium.* Goodsir admitted that each digestion is at-

*The layer of cells forming the surface of membranes, as the mucous membrane of the alimentary canal. The skin is essentially a modified mucous membrane, and the thickened epithelium is called cuticle or epidermis.—TRANSLATOR.

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tended by a loss and renewal of intestinal epithelium. In the trachea, (windpipe) there is an analogous process under certain pathological conditions. Hunter has shown that in the sparrow the generative organs, ovary and testis, atrophy and diminish until the time when their functions are again called into action. Stannius has made a similar observation with certain batrachians. More than this, these phenomena of retrogression and repair extend to the nerves and nervous ganglia attached to these organs. In all these cases the repair is accomplished by a mechanism analogous to that of the development of the embryo.

Certain instances of loss and regeneration are even more complete. Among the lower animals a limb, a part of the body, even half of the animal may be replaced at the expense of the remaining parts. Thus a planaria cut in two, forms two planariæ like the first; it is a sort of artificial fissiparity. The anterior half adds to itself a a posterior half, and the posterior half forms an anterior half. But the two planariæ created in this manner, taken together, only make up the same bulk as the original animal.

If, then, we continue the subdivision there will come a time when reconstruction is no longer possible unless we wait until the animal has had time to acquire its normal size. It is necessary to understand also that the newly developed portion is not a mere bud of the preëxisting fragment, but this latter is used as a whole to form a new planaria.

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With some reptiles, as the lizards, a part may be replaced after destruction. The tail of a lizard, if cut off, is reproduced. By weighing the animal before the experiment and after the restoration of the part, we find that it is at the expense of the proper substance that the injured part is repaired. Dugès even obtained a still more curious result from the following experiment. He cut the tail half through at the base. It remained adherent, and in the wound a second was developed. The lizard, after cicatrization, had two tails. With the crustacea a limb removed is replaced by another; the latter is formed under the carapace, and only increases at the time this is shed.

This repair of lost parts, among the lower animals, has suggested a question, the solution of which by experiment will have the highest interest. Can a limb removed in its totality be replaced by another? Philippeaux, making his experiments upon the salamander, has noted that when the whole limb, together with the shoulder, is removed no renewal takes place. This would indicate that the limb may be a sort of unity in itself, and that the part left attached to the animal acts as a germ whence proceeds the new limb.

On the other hand, Legros has performed experiments in which, having removed the entire stump, including the shoulder, with the greatest care, he has nevertheless, as he states, obtained a regeneration. If there is no error in the mode of operating, there may

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be some condition sufficient to account for the contradictory results. It would be necessary to ascertain, for instance, whether, according to the age of the animal, the limb can reproduce itself or not when removed completely, as we would be authorized to think from analogous facts.

We have already had occasion to cite the experiments of M. de Sinéty upon the ablation of the mammary gland with Guinea-pigs. This operation had been at first performed upon adult females, with the purpose of learning whether, at the time of parturition, the organ would be reproduced. Nothing of the kind took place, and the young died of hunger, parturition having gone on as usual. Repeating the experiments upon very young individuals, M. de Sinéty found the gland reproduced; and in one case a new nipple was perfectly formed. It might still be objected that with young animals the gland could not be properly said to exist as yet; that possibly there had been removed only the tissue which ought to produce it, and that embryonic cells which escaped removal had served as the point of departure for the regeneration of the organ. The results are none the less remarkable.

With the higher animals, other tissues, and even the most specialized, the nerves, for example, are still capable of regeneration. We have no intention of entering into the details of all these phenomena; we wish only to show that regeneration takes place

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always by the same process, through the medium of an embryonic tissue. If we cut the sciatic nerve of an animal, there results in the corresponding limb a loss of function, paralysis of sensibility and of motion. After a time, varying according to the species, we find that the properties of the nerve are restored; we must then admit that the organ is reëstablished. M. Ranvier has studied with great care all the anatomical phenomena of the degeneration and regeneration of nerves, applying to that study the new light resulting from his investigations upon the structure of the nerves. M. Ranvier has found that the nerve tube is not an anatomical unit. Of the three parts which compose a nerve fiber, the sheath of Schwann (commonly known as neurilemma), the envelope of myeline (commonly known as the white substance of Schwann), and the axis-cylinder, one only is continuous throughout the entire nerve; this is the axis-cylinder. The other two are interrupted at intervals by constrictions. They are segments placed end to end, each having a nucleus, and comporting themselves like cellular elements. After the section of the nerve, the peripheral portion degenerates; the myeline becomes opaque and granular. The nuclei of the segments multiply, the axis-cylinder disappears. Then, after a certain time, a work of regeneration commences, starting from the central portion, and the segments of the nerve fiber are reconstructed.

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Now those segments have a certain length, about one millimetre in the adult, but varying in young animals according to their stage of development. If, then, we examine these segments in a nerve in process of reconstruction, we find that they become longer and longer, and that these variations in length correspond precisely with those which we observe in the fœtus during development. In short, the regeneration of nerves is accomplished in the same way as is that of the tissues which we have studied, by the embryonic processes.

This general law establishes a new bond of union between the evolutional phenomena which constitute reproduction and those which belong to nutrition properly so-called, for redintegration and regeneration may thus be regarded as intermediate between reproduction and nutrition.

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# APPENDIX—C.

## LIST OF PAPERS BY THE AUTHOR.

1 Contributions to the comparative myology of the Chimpanzee (*Troglodytes niger*). Boston journal of natural history, vol. VI, *353–384*, 1861.

2. On morphology and teleology, especially in the limbs of Mammalia. Memoirs Boston soc. nat. hist., vol. I, No. 1, 1865, pp. 35; 3 figures. (Read June 3d, 1863).

3. Histories of two surgical specimens (2639 and 3159) in the Army Medical Museum. Boston med. and surg. journal, Nov. 10th, 1864, *292–294*.

4. On the *Nephila plumipes*, or silk-spider of South Carolina. Proc. Boston soc. nat. hist., Oct. 4th, 1865; pp. 11, 2 figures.

5. On the *Nephila plumipes*, or silk-spider. Proc. American academy of arts and sciences, Nov., 1865, *52–57*.

6. On the silk-spider of South Carolina. Four lectures before the Lowell Institute, Boston, Mass., 1866. (Unpublished).

7. Pathological polarity, or what has been called symmetry in disease. Boston med. and surg. journal, April 5th, 1866, *189–198*.

8. On a cat with supernumerary digits. Proc. Boston soc. nat. hist., May 16th, 1866, *3–6*.



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9. On the morphological value and relations of the human hand. Abstract of a paper read before the National academy of science, Aug. 8th, 1866. Am. journ. of science, July, 1867, *44–48;* 1 figure.

10. Researches and experiments upon silk from spiders. (Termeyer, 1810–1820?). Translation edited by B. G. W. Proc. Essex institute, Salem, Mass., July, 6th, 1866, *51–79;* 2 figures.

11. How my new acquaintances spin. Atlantic monthly, August, 1866 *129–145;* 9 figures.

12. Memoirs of a cripple. Our young folks, Sept., 1866, *534–546;* 9 figures.

13. The hand as an unruly member. American naturalist, vol. I, Oct., Nov., 1866, Jan., 1867, *414–422, 482–491, 631–638;* 13 figures.

14. Two hundred thousand spiders. Harper's magazine, March, 1867, *450–466;* 23 figures.

15. On a method of recording and arranging information. Proc. Boston soc. nat. hist., May 15th, 1867, *242.*

16. On symmetry and distorted symmetry in the leaves of plants. Proc. Boston soc. nat. hist., Nov. 6th, 1867, *314, 315;* 2 figures.

17. On the morphological value and relations of the human hand. Six lectures delivered at the Museum of comparative zoölogy in Cambridge, Dec. 6th, 1867, to Jan. 10th, 1868. (Unpublished).

18. Extra digits. Publications of Massachusetts medical society, II, no. 3, *305–327;* 1 figure. Read at annual meeting, June 2d, 1868.

19. The practical view of spider's silk. The Galaxy, July, 1869, pp. 10; 10 figures.

20. Beast, bird and fish; or forms of animal locomotion. Harper's Magazine, Nov. and Dec., 1869, Jan. and Feb., 1870, pp. 34; 37 figures.

21. Six fingers and toes. Old and new, Feb., 1870, pp. 6.

22. Something about bats. Hours at home, Feb., 1870, *321–326.*

23. Hands and feet of Mammalia. Twelve lectures before the Lowell Institute, Feb. and March, 1870. (Unpublished).

24. Time works wonders. Atlantic monthly, March, 1870, *321–332.*

25. Right and left. Atlantic monthly, April, 1870, *455–466.*

26. Equal, yet diverse. Atlantic monthly, July, 1870, *30–40.*

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27. Fingers and toes. Hours at home, July, Aug., Oct., 1870, pp. 17.

28. Human locomotion: how we stand, walk and run. Trans. of the American institute, 1870–1871, pp. 18; 15 figures.

29. Kings of the air. Scribner's monthly, Jan., 1871, *239–246;* 7 figures.

30. Intermembral homologies: the correspondence between the anterior and posterior limbs of Vertebrates. Proc. Bost. soc. nat. hist., Apr. 5th, 1871, XIV, *154–242;* 5 figures.

31. Aye-aye (*Cheiromys Madagascariensis*). Scribner's monthly, May, 1871, *33–39;* 7 figures.

32. As others see us. Scribner's monthly, May, 1872, *334–338;* 10 figures.

33. The brain, and the present scientific aspect of phrenology. A lecture before the American Institute, Jan. 20th, 1873. N. Y. Tribune, Jan. 21st, 1873, and Tribune Extra no. 3; 15 figures.

34. Cyno-phrenology. Boston med. and surg. journal, Jan. 26th 1873, LXXXVIII, *73–78.*

35. The Anderson school of natural history. The Nation, Sept. 11th. 1873, pp. 2.

[The following papers (36 to 48 inclusive) were presented at the meeting of the American association for the advancement of science, 1873, and are published in the Proceedings for that year).

36. The outer cerebral fissures of Mammalia, especially the Carnivora, and the limits of their homologies. *214–233;* 19 figures.

37. Variation in the cerebral fissures of domestic dogs, and its bearing upon scientific phrenology. *234–249;* 6 figures.

38. Lateral asymmetry in the brains of a double human monster. *250, 251;* 4 figures.

39. The papillary representative of two arms in a double human monster. *251–256;* 3 figures.

40. The habits and parasites of *Epeira riparia, 257–263;* 8 figures.

41. The nets of *Epeira, Nephila* and *Hyptiotes* (*Mithras*). *264–274;* 3 figures.

42. The need of a uniform position for anatomical figures; with a recommendation that the head be always turned to the left. *274.*

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43. Lateral position of the vent in *Amphioxus*, and in certain Batrachian larvæ. *275–300*; 10 figures.

44. Composition of the carpus in dogs. *301, 302*; 1 figure.

45. Present aspect of the question of intermembral homologies. *303*.

46. Variation in the condition of the sense organs in fœtal pigs of the same litter. *303–304*; 2 figures.

47. The pectoral muscles of Mammalia. *305–307*.

48. Variation in the pectoral muscles of domestic dogs. *308*.

49. On secret societies. N. Y. Tribune, Oct. 22d and Nov. 8th, 1873.

50. A baby fox. Popular science monthly, Aug., 1874, *443–447*; 1 figure.

51. Note on the gestation of the little brown bat (*Vespertilio subulatus*). Proc. Am. ass. adv. science, 1874.

52. Jeffries Wyman. Old and new, Nov., 1874, *533–544*.

53. Sketch of Dr. Jeffries Wyman (with a portrait). Popular science monthly, Jan., 1875, pp. 6.

54. The triangle spider. Popular science monthly, April, 1876. *625–635*; 11 figures.

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# AUTHORS CITED.*

1. QUAIN, E.: Elements of anatomy. Seventh edition; edited by W. Sharpey, Allen Thomson and John Cleland. In two volumes; 8vo, pp. 1147; 718 figures. London, 1867.

2. DALTON, J. C.: A treatise on human physiology, designed for the use of students and practitioners of medicine. Second edition; pp. 690, 8vo; 271 figures. Phil., 1861.

3. GRAY, HENRY: Anatomy, descriptive and surgical. A new American, from the fifth English edition; pp. 876, 8vo; 462 figures. Phil., 1870.

* The order of enumeration has no significance; some of the latest and most important works are named among the last.

In the text the above-named authors are referred to as follows. The first number designates the number of the author upon this list. The last number (*italics*) indicates the *page*. The middle number, when it occurs, (in Roman numerals) refers to the VOLUME of the work. Thus Quain, 1, II. *600* means the six hundredth page of the second volume of Quain's Anatomy.

In this list the numbers of the *pages* referred to are in *italics*.



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4. WYMAN, JEFFRIES: Observations on the development of the "Surinam toad" (*Pipa Americana*). Presented to the Boston society of natural history. American journal of science and art, May, 1854, *369–374;* 5 figures.

5. WEINLAND, D. F.: Ueber den Beutelfrosch (*Notodelphys ovifera*). Müller's Archiv für Anatomie, 1854, *449–471*, pl. xvii to xix.

6. AGASSIZ, L.: Additional notes on the Holoconoti (embiotocoid fishes). American journal of science, May, 1854, *365–369.*

7. BLAKE, JAMES: On the nourishment of the fœtus in embiotocoid fishes. Journal of anatomy and physiology, II, *280–282.*

8. TURNER, W.: On a remarkable mode of gestation in *Arius Boakei.* Journal of anatomy and physiology, *i, 78–82.*

9. STORER, H. R.: Is it I? a book for every man. 16mo, pp. 154; Boston, 1868.

10. CARPENTER, W. B: Principles of human physiology. New American edition; pp. 900, 8vo; 300 figures.

11. SPENCER, HERBERT: Principles of biology. American edition; two volumes; 12mo, pp. 1040; 300 figures. N. Y., 1866 and 1867.

12. CUVIER, GEORGES: Leçons d'anatomie comparée. Rédigées et publieés par G. L. Duvernoy. 2me édition; t. 1–8, 8vo, pp. (average of each volume) 700. Paris, 1835–1846.

13. WARE, JOHN: Hints to young men on the true relation of the sexes. 16mo, pp. 65. Boston.

17. OWEN, R.: On the anatomy of vertebrates. 3 vols., 8vo, pp. 2155; 1471 figures. London, 1861–1868.

18. BURNETT, W. I.: Researches on the development of the viviparous Aphides. American journal of science, 1854, *62–78;* 6 figures.

19. WILKINSON, J. J. G.: The human body and its connection with man. 8vo., pp. 411. Phil., 1851.

20. FERRIS, B. G.: A new theory of the origin of species. 12mo, pp. 70. Ithaca, N. Y., 1872.

29. WYMAN, JEFFRIES: On some unusual modes of gestation. American journal of science, second series, 1859, XXVII, *5–13;* 5 figures. (From Proc. Boston soc. nat. hist., Sept. 15, 1857).

Digitized by Google

32. WILDER, B. G.: Intermembral homologies, the correspondence between the anterior and posterior limbs of vertebrates. Proc. Boston soc. nat. hist., April 5th, 1871, XIV, *154–188, 309–339, 399–420.*

33. OWEN, R.: Lectures on the comparative anatomy of invertebrates. 8vo, pp. 688; 235 figures. London, 18—.

34. THOMSON, ALLEN: Article, "Generation." Cyclopædia of anatomy and physiology, II, *424–480.*

37. ROLLESTON, GEORGE: Forms of animal life; being outlines of zoölogical classification based upon anatomical investigation, and illustrated by descriptions of specimens and of figures. 8vo, pp. 436; 12 plates. Oxford, 1870.

38. ACTON, W.: Functions and disorders of the reproductive organs. 8vo. London, 1865.

44. BURNETT, W. I.: Case of bisexual hermaphroditism. Proc. Boston soc. nat. hist., IV, *353*, Sept. 7, 1853.

46. NAPHEYS, GEO. N.: The transmission of life; counsels on the nature and hygiene of the masculine function. Fourteenth edition; 12mo, pp. 346. Phil., 1872.

52. SIMPSON, J. F.: Article, "Hermaphroditism." Cyclopædia of anatomy and physiology, II, *684–738.* 20 figures. London, 1839.

53. FOTHERGILL, J. M.: The maintenance of health, a medical work for lay readers. 12mo, pp. 339. London, 1874.

54. BURNETT, W. I.: Researches on the development and intimate structure of the renal organs of the four classes of the Vertebrata. American journal of science, 2d series, XVII, *374–386.*

57. The gynæcological journal; the journal of the gyn. society of Boston. Edited by Winslow Lewis, M. D., H. R. Storer, M. D., and George H. Bixby, M. D.

58. CROSBY, HOWARD: My objections to secret societies. The Congregationalist, 1871, XXIII, No. 16; reprinted in the Ithaca Journal of Oct. 16th, 1873.

59. WILDER, B. G.: On secret societies. New York Tribune, Oct. 22d and Nov. 8th, 1873.

60. CLARKE, E. H.: Sex in education; or, a fair chance for the girls. 16mo, pp. 181. Boston, 1873.

Digitized by Google

61. BRACKETT, Miss ANNA C.: The education of American girls. 12mo, 1874.

62. WYMAN, J.: Observations on the development of *Anableps Grmnovii*. Boston journal of natural history, V, *432*, *433*, 1854.

63. HUXLEY, T. H.: Manual of the comparative anatomy of vertebrated animals. Am. ed. N. Y., 1872. 12mo, pp. 431; 110 figures.

64. STRICKER: Manual of human histology. Am. edition. N. Y., 1872. 8vo, pp. 406; 431 figures.

65. FARRE, ARTHUR: Article, "The uterus and its appendages." Cyc. of anat. and phys., V (supplement), *545–725*; 120 figures. London, 1859.

66. THOMSON, ALLEN: Article, "Ovum." Cyc. of anat. and phys., V (supplement), *1–142*; 95 figures.

67. WILDER, B. G.: Extra digits. (Read at the annual meeting of the Massachusetts medical society, 1868). Publications of the Mass. med. soc., II, No. 3, *305–326*.

69. AGASSIZ, Mrs. E. C. and Mr. A.: Seaside studies in natural history; marine animals of Massachusetts bay; radiates. Second edition, 8vo, pp. 157; 185 figures. Boston, 1871.

71. AGASSIZ, LOUIS: Contributions to the natural history of the United States. Four volumes; 4to, pp. 1324; 62 lithographic plates and many wood-cuts in the text. Boston, 1857–1862.

72. HALL, W. W.; Sleep; or, the hygiene of the night. Eleventh thousand; pp. 357. London, 1871.

74. VAN DE WARKER, E.: The genesis of woman. Popular science Monthly, July, 1874.

75. ALLEN, NATHAN: Medical problems of the day. The annual discourse before the Mass. Med. Soc., 1874. Pp. 69. Boston, 1874.

76. KOLLIKER, A.: Manual of human histology. Translated and edited by George Busk and Thomas H. Huxley. 12 vols., 8vo, pp. 932; 313 figures. The Sydenham society, London, 1853–4.

78. HAECKEL, ERNST: Natürliche Schöpfungsgeschichte. Gemeinverständliche wissenschaftliche Vorträge über die Entwickelungslehre im Allgemeinen und diejenige von Darwin, Goethe und Lamarck im Besonderen. Vierte verbesserte Auflage. Mit 16 Tafeln, 19 Holzschitten, 18 Stammbäumen und 19 systematischen tabellen, 8vo, pp. 688. Berlin, 1873.

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79. WILDER, B. G.: Equal yet diverse. Atlantic Monthly, July, 1870. *30–40.*

80. OWEN, RICHARD: A discourse on parthenogenesis. 8vo. London, 1849.

81. SWEDENBORG, EMANUEL: The generative organs, considered anatomically, physically and philosophically. (A posthumous work). Translated from the Latin by J. J. G. Wilkinson. London, 1852.

82. WILDER, B. G.: The papillary representative of two arms of a double human monster, with a note upon a mummied double monster from Peru. Proc. Am. ass. adv. science, 1873, *251–256;* 3 figures.

83. WYMAN, J.: On symmetry and homology in limbs Proc. Boston soc. nat. hist., June 5th, 1864, *246–278;* 14 figures.

84. WYMAN, J.: Description of a double fœtus. Boston med. and surg. journal, March 29th, 1866, *169–176;* 1 figure.

85. COUES, E.: Antero-posterior symmetry, with special reference to the muscles of the limbs. Medical Record, N. Y., June 1, July 1, 15, Aug. 15, Sept. 1, Oct, 1, 15, Nov. 1, 1870.

86. WYMAN, J.: On the cells of the honey-bee. Proc. Am. acad. arts and sciences, Jan. 9th, 1866, *68–82;* 6 figures.

87. WILDER, B. G.: On the nets of *Epeira*, *Nephila* and *Hyptiotes.* Proc. Am. ass. adv. science, 1873, *264–274;* 3 figures.

89. COMFORT, Prof. G. M. and Mrs. A. M.: Woman's education and woman's health, chiefly in reply to "Sex in education." Pp. 155, 16mo, Syracuse, 1874.

90. FLINT, AUSTIN, Jr.: The physiology of man; designed to repretent the existing state of physiological science, as applied to the functions of the human body. Vol. V, Special senses; Generation; pp. 517, 8vo; 52 figures. New York, 1874.

91. WILDER, B. G.: Jeffries Wyman; a sketch of his life and works. Old and New, Nov., 1874, *533–544.*

94. THOMAS, T. G.: A practical treatise on the diseases of women. Pp. 624, 8vo; 219 figures. Phil., 1868.

95. PHELPS, Miss E. S.: What to wear. Pp. 92, 12mo. Boston 1874.

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96. WILDER, B. G.: Note on the gestation of the little brown bat, *Vespertilio subulatus* (Say). Proc. Am. ass. adv. science, 1874.

97. BISCHOFF, T. L. W.: Entwickelungsgeschichte des Hundes-Eies. Ss. 135, 4to; mit fünfzehn steintafeln. Braunschweig, 1845.

98. BOYD, Rev. N. E.: To the studious and thoughtful. Published by the moral education society of Washington, D. C. Pp. 8. 12mo. Washington, 1874.

99. CLARKE, E. H.: The building of a brain. 16mo. Boston, 1874.

100. VAN BENEDEN, E.: De la distinction originelle du testicule et de l'ovaire; . . essai d'une théorie et la fécondation. Pp. 68; deux pl. Bruxelles, 1874. (Extrait des bulletins de l'academie royale belgique, 2me sériée, t. xxxvii, nº 5, Mai, 1874).

101. CLELAND, JOHN: Animal physiology; the structure and functions of the human body. Pp. 325, one hundred and fifty-eight figures. London, Glasgow and New York, 1874.

102. AGASSIZ, ALEXANDER: Embryology of the Ctenophoræ. With 5 plates and figures printed in the text. Memoirs of the Am. acad. of arts and sciences, X, No. III, August. Cambridge, 1874.

103. WOOLSON, Mrs. C. M.: Dress reform. Pp. 263, 12mo; with two plates. Boston, 1874.

104. HAECKEL, E: Anthropogenie oder Entwickelungsgeschichte des Menschen; gemeinverständliche wissenschaftliche Vorträge über die Grundzüge der menschlichen Keimes- und Stammesgeschichte. Pp. 732, 8vo; mit 12 Tafeln, 210 Holzschnitten und 36 genetischen Tabellen. Leipzig, 1874.

105. LOCKWOOD, Rev. S.: The sea-horse (*Hippocampus*) and its young. The American naturalist, July, 1867, *225–237*; 3 figures.

106. PACKARD, A. S.: The life-history of the Protozoa. The American Naturalist, Dec., 1874, and Jan., 1875; illustrated.

107. BALFOUR, F. M.: A preliminary account of the development of the elasmobranch fishes (Selachians). (Read in section D, at Belfast meeting of British association for advancement of science). Quarterly journal of microscopical science, October, 1874, No. lvi, *323–364*, with three plates. (This important paper on the embryology of sharks and skates was received too late for incorporation of the results with this work).

Digitized by Google

108. BERNARD, CLAUDE: Phénomènes de la vie communs aux animaux et aux végétaux. Cours au muséum d'histoire naturelle de Paris, 1874. Revue scientifique de la France et de l'étranger, 1874, Nos. 13, 14, 15 16, 17, 18, 19, 20 (Sept., Oct. and Nov.).

109. HAECKEL, ERNST: The gastræa theory, the phylogenetic classification of the animal kingdom and the homology of the germ-lamellæ. Quarterly journal of microscopical science, April and July, 1874, *142-165* and *223-247*.

111. HOLMES, O. W.: The Americanized European. The Atlantic monthly, Jan., 1875, *75-85*. (A review of Dr. Clarke's works, 60 and 99).

112. VAN DE WARKER, ELY: The relations of women to the professions and skilled labor. Popular science monthly, Feb., 1875, *454-470*.

113. HUXLEY, T. H.: On the classification of the animal kindgdom. Quarterly journal of microscopical science, Jan., 1875, *52-56*.* (Read before the Linnean society, Dec. 4th, 1874. Reprinted from Nature).

* In this number of the journal are several notes and reviews respecting the development of the embryonic layers and the structure and origin of the internal reproductive organs.

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